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CAMBRIDGE
AT THE UNIVERSITY PRESS
1935

PRINTED IN GREAT BRITAIN BY WALTER LEWIS, M.A., AT THE UNIVERSITY PRESS, CAMBRIDGE

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[*Discovery Reports. Vol. X, pp.* 1–208, *Plates I–X, December,* 1934]

FORAMINIFERA

PART III. THE FALKLANDS SECTOR OF THE ANTARCTIC (EXCLUDING SOUTH GEORGIA)

By

ARTHUR EARLAND, F.R.M.S.

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FORAMINIFERA

PART III. THE FALKLANDS SECTOR OF THE ANTARCTIC (EXCLUDING SOUTH GEORGIA)

By Arthur Earland, F.R.M.S.

(Plates I–X; text-figs. I, II)

INTRODUCTORY NOTE

THE first part of this report dealt with the bottom deposits of the Falkland Islands and adjacent seas, an area outside the extreme limit of pack-ice, with a characteristic sub-Antarctic fauna. The second part with the deposits of South Georgia, which lies within the Antarctic region, although very nearly in the same latitude as the Falkland Islands. The present report will deal with a large area farther south, extending over nearly 90° of west longitude, or practically a quarter of the South Polar circumference. With the exception of four deep-water soundings from the Drake Strait and Scotia Sea (Sts. 386, 387, WS 205, 468), all the gatherings are from within the Antarctic convergence line,[1] which is accepted as the boundary of the Antarctic region. These four stations outside the convergence, and two stations (St. 385, WS 469) which are near the line, have furnished valuable data as to the extent and influence of Pacific incursions into the Antarctic area. Apart from pelagic species, they are more in accord with the material dealt with in the present report than with the sub-Antarctic fauna of the Falklands.

The area included in this report extends from St. WS 552 in the Weddell Sea (68° 53′ S, 13° 03′ W) to St. WS 503 in the Bellingshausen Sea (70° 03′ 30″ S, 100° 39′ W). It includes the Scotia Sea and Drake Strait, the South Sandwich, South Orkney and South Shetland groups of islands, the Bransfield Strait, Palmer Archipelago, the Graham Land coast, and a few scattered soundings in the Bellingshausen Sea. One hundred and twenty-six samples of material were received and examined, of which 106 were soundings, nine dredgings, three residues from trawl, four residues from nets attached to dredge or trawl, and four beach sands or anchor mud. As might be expected in gatherings made under difficult conditions over such an immense area, the material is not evenly distributed, a very large proportion consisting of soundings from the limited area of the Bransfield Strait and Palmer Archipelago, where much survey work was done by the ships. The advent of echo sounding will in future deprive zoologists of much material hitherto obtained as a by-product of marine surveying.

---

[1] The Antarctic convergence is the point at which the cold heavy Antarctic surface water meets the warmer but more saline sub-Antarctic surface water. It is marked by a sharp change of temperature with corresponding climatic changes. It roughly corresponds with the extreme limit of pack-ice. The convergence varies little in position with the seasons, and runs for the most part in about latitude 50° S, dipping to below 60° S in the longitude of Cape Horn.

THE ANTARCTIC FORAMINIFERAL FAUNA

The foraminiferal fauna of the Antarctic, especially when unaffected by external influences, as appears to be the case in the Weddell Sea, is limited in both genera and species, and primitive in nature, being principally Arenacea. In this respect it is very similar to the fauna of the deep sea in all latitudes of the great oceans, many of the Antarctic species being truly cosmopolitan, and others represented in the deep sea by closely allied forms. Whether the deep sea was populated by migration from cold polar waters, or conversely whether the Antarctic fauna had its origin in the deep sea, is a matter for conjecture. On the evidence afforded by the Discovery material, supplemented by the records of the 'Scotia', 'Terra Nova' and 'Gauss', I am personally inclined to the view that the Antarctic fauna originated in migration principally from the deep water of the adjacent oceans, and that the invasion is still in active progress. With the exception of a limited number of species which appear to have a circumpolar distribution, and are not found in the deep sea of warmer latitudes, I think the present Antarctic fauna represents the successful attempts at the colonization of a fresh area. The conditions of life have not favoured the development of the porcellanous and hyaline forms to the extent which they have attained in the shallow waters of temperate and tropical seas, and with few exceptions these forms play only a secondary part in the Antarctic.

For the purpose of comparison of the faunas of the widely differing regions covered by this report, the area was subdivided as follows, working westwards:

I. WEDDELL SEA

Sts. WS 552, 553, 555.[1]

The primitive nature of the Weddell Sea fauna is well illustrated by the few soundings received. All species are arenaceous except single starved specimens of *Cassidulina*, *Globigerina* and *Globorotalia*, and most of them are of cosmopolitan distribution. But the material received was insufficient for any general deductions, and must be considered in connection with Pearcey's records from this region. Many fossil *Globigerinae* were found at St. WS 555 (see p. 22).

II. SOUTH SANDWICH ISLANDS

Sts. 363, 365–7, 369.

The residues from this area are largely scoriae and volcanic ash, and as a result all the Arenacea are very dark in colour. Foraminifera form only a small proportion of the residues but are varied in species. Specimens are few in number, except in the case of *Miliammina* and some other forms, mostly cosmopolitan. A few species were recorded which are either confined to this area or much rarer elsewhere, e.g. *Ophthalmidium inconstans*, *Pilulina arenacea*, *Botellina goësii*, *Trochammina grisea*, *Cassidulina lens*, *Elphidium magellanicum*. There are not many species indicative of Pacific influence, but among them may be reckoned the *Opthalmidium* and *Elphidium*, also *Sigmoilina obesa* and *Ehrenbergina pupa*.

---

[1] Full details of the stations will be found on pp. 26–44.

III. SOUTH ORKNEY ISLANDS TO CLARENCE ISLAND ON THE CONTINENTAL SHELF AND SLOPE

Sts. 162–4, 167, 169, 170; WS 475.

The terrigenous muds and net residues received from the South Orkney Islands were very poor in Foraminifera, and presented no features of particular interest except the presence of *Gordiospira fragilis*, not found elsewhere in the collections, and three species, *Hippocrepina oviformis*, *Hippocrepinella hirudinea*, *H. alba*, of which there are few other records.

By contrast the dredging made at St. 170, off Cape Bowles, Clarence Island, on a bottom of rock, stones and mud was extraordinarily rich in species, although Foraminifera formed hardly any visible proportion of the material. Several new species were recorded from this station and many others which were of infrequent occurrence elsewhere: *Sorosphaera socialis*, *Psammophax consociata*, *Thurammina corrugata*, *T. cariosa*, *Verneuilina superba*, *Heronallenia wilsoni*, *Lagena heronalleni*, *L. texta*, etc. I understand that the material from St. 170 was exceptionally rich in all forms of animal life. Pacific influence is marked in this area by the numerous specimens of *Globigerina bulloides*, and such other species as *Sigmoilina obesa*, *Rotalia beccarii* and *Elphidium owenianum*.

IV. SCOTIA SEA FROM 29° 15′ W TO 60° W

Sts. 161, 360, 362, 373; WS 199, 201–5, 377, 403, 468–9, 471–2, 474.

These are all deep-water stations, diatom ooze, red clay, *Globigerina* ooze, or mixed deposits in which diatoms and Radiolaria predominate over Foraminifera. Arenacea of world-wide distribution and various species of *Globigerina* form a high proportion of the residues, mixed with a number of species of decided Antarctic facies. A number of new species and several new genera were obtained in this area, generally minute forms. Pacific influence is strongly marked, particularly at the western stations. The only specimen of *Hastigerina pelagica* was found at St. 161 near the centre of the Sea. *Globigerina bulloides* and *G. triloba* were common at Sts. WS 204 and 469, which are very near the convergence. They diminish rapidly in numbers at the inner stations. Among other species indicating Pacific influence are *Sigmoilina obesa*, *S. sigmoidea*, *Cassidulina laevigata*, *C. pulchella*, *Spiroloculina pusilla*, *Ehrenbergina bradyi*, *Laticarinina pauperata*, *Globorotalia hirsuta*, *G. scitula*, *Verneuilina bradyi* and *Gaudryina ferruginea*.

V. DRAKE STRAIT FROM 60° W

Sts. 382–7; WS 400.

The material came from a line of deep-water stations, 382–7, between the South Shetlands and Cape Horn crossing the convergence between Sts. 385 and 386; and another St., WS 400, not far from St. 382. The southern stations were red clay, passing into *Globigerina* ooze towards the northern side of the Strait. Very long lists of species were obtained at all the stations except Sts. 382, 387 and WS 400, including many genuinely Antarctic species. *Globigerinae* and *Globorotaliae* of various species form the bulk of the foraminiferal residues at Sts. 384–7, but (except *G. pachyderma*, common) are curiously rare at St. 383, represented by two specimens of *G. pachyderma* at St. 382 and entirely absent at St. WS 400. Several new species were found in the area, also many of those recorded in the Scotia Sea. Signs of Pacific influence are numerous at the pairs of stations 384, 385 and 386, 387 on each side of the convergence. Apart from the evidence of the *Globigerinae* and *Globorotaliae*, Sts. 384, 385 and 386 have an extraordinary variety of *Lagenae*, many of which have not been recorded except in the south-west Pacific. Other species known as Pacific species found in this area include *Cassidulina pacifica*, *C. elegans*, *Virgulina schreibersiana* var. *complanata*, *Ehrenbergina hystrix*, *E. bradyi*, *Bolivina decussata*, *Polymorphina extensa* and *Gaudryina ferruginea*.

VI. BRANSFIELD STRAIT AND SOUTH SHETLAND ISLANDS

Sts. 171–2, 175, 177, 194–204, 206, 209, 377; 62° 57′ S., 60° 20′ 30″ W.; WS 381–9, 391–6, 399, 476, 479, 480–90, 493, 494 A, 494 B.

The Bransfield Strait, which could not be marked in Fig. 2 on account of the crowded stations in it, is a broad land-locked sea between the South Shetlands and the northern extremity of Graham Land. A great variety of material was received from the Strait and southern coasts of the South Shetlands, but there is unfortunately none from the northern or outer coast of those islands. Nearly all the gatherings received were soundings, terrigenous or volcanic muds, and they give a first impression of a region with scanty foraminiferal fauna, some fifty species constituting a general list, selections from which, varied at nearly every station, give an average of probably less than thirty species for each station. But now and again there is a richer sounding, and from these, and from a few dredgings, quite a long list of genera and species has been obtained, including a number of new or rare and interesting species. On the gatherings as a whole we can construct a very good general idea of the fauna of an Antarctic continental shelf and slope. Arenacea predominate both in species and specimens; *Globigerinae*, except *G. pachyderma*, take quite a secondary position; Miliolidae are rare, although the large size attained by some species of *Pyrgo*, which are not uncommon, makes them conspicuous by contrast with the small size of most of the organisms; the Textulariidae are well represented as regards species, but play quite an inconspicuous part in the whole, as also do the Lagenidae, in spite of the fact that they are represented by many genera and species. The other families are poorly represented.

Among the new or otherwise interesting species obtained from this region were *Astrorhiza polygona*, *Pilulina jeffreysii*, *Thurammina spumosa*, *T. corrugata*, *Bathysiphon argillaceus*, and *Ehrenbergina parva*.

Pacific influence is greater than might have been expected in such a land-locked area. A long list of species could be compiled, including species already recorded in the Falklands area, and others known hitherto only from the Ross Sea and south-west Pacific. Among others are *Bolivina compacta*, *Bulimina patagonica*, *Cassidulina pulchella*, *C. laevigata*, *Cibicides dispars*, *Dendronina arborescens* var. *antarctica*, *Discorbis turbo*, *D. vilardeboana*, *Ehrenbergina pupa*, *Elphidium macellum*, *E. owenianum*, *Globigerina bulloides*, *G. triloba*, *Globorotalia crassa*, *G. menardii*, *Hyperammina clavigera*, *Lagena* *alveolata* var. *separans*, *L. quadralata*, *L. revertens*, *Miliolina insignis*, *Nonion sloanii*, *Ophthalmidium margaritiferum*, *Rotalia beccarii* and *Virgulina schreibersiana* var. *complanata*.

VII. PALMER ARCHIPELAGO

Sts. 180–2, 185–7, 190–2; 64° 56′ S., 64° 43′ W.; Port Lockroy.

The soundings received from this land-locked area were terrigenous muds which gave little promise of a rich foraminiferous fauna, the residues as a rule yielding only a few common species, chiefly Arenacea. The dredgings and residues from nets revealed an extremely abundant fauna, characterized by the large size attained by many species on what must have been a rich feeding ground. The genus *Pelosina* in particular was abundant to a degree I have never seen equalled, and nearly all the known species were obtained, some attaining unusual dimensions. *Reophax* was also well represented in species and attained great dimensions, *R. pilulifer* being unusually large and common. Many interesting species were recorded. *Operculina balthica* (the only record) at St. 180; *Sorosphaera socialis*, *Bathysiphon argillaceus*, *Thurammina spumosa* and *Cibicides grossepunctatus*, which last is common in several gatherings.

In such a land-locked area Pacific influence is not very conspicuous, but a few species indicate the presence of warmer water; e.g. *Globigerina bulloides* is sometimes frequent, and there are records of *Globorotalia scitula*, *Bulimina inflata*, *B. patagonica*, *Dendronina arborescens* var. *antarctica*, *Globigerina triloba*, *Sigmoilina sigmoidea*, *Rotalia beccarii* and a few others.

VIII. BELLINGSHAUSEN SEA

Sts. WS 495–9, 502–3, 505–7 B, 509–17.

The material consisted of soundings made on the continental shelf and slope between 179 and 2770 m., and two deeper soundings, Sts. WS 502, 503, on the floor of the Bellingshausen Sea in over 4000 m. The inshore soundings were terrigenous grey and brown muds, the deeper were red clay. Most of them yielded a characteristic Antarctic fauna with a limited number of species, chiefly Arenacea, but at many of the stations this fauna was more or less obscured by the abundant *Globigerinae*. *G. pachyderma*, with occasionally *G. conglomerata*, sometimes formed up to 80 per cent of the residues, a most unusual occurrence in such high latitudes. In addition to the normal Antarctic forms, a number of interesting records were made including many of the new species recorded from the Scotia Sea and Drake Strait: *Reophax micaceus*, *Cystammina argentea*, *Spirolocammina tenuis* and *Placopsilinella aurantiaca*. *Rupertia stabilis* was found at St. WS 505, more than 20° S of its previous record to the north of the Falklands. *Hormosina lapidigera*, *Thurammina murata* and *Psammophax consociata* were all found at a great distance from their previously known localities.

Pacific influence appears to be even more strongly marked in this region than in the others. The influx of warm water is shown by the abundant *Globigerinae*. *Globigerina pachyderma* might be expected to occur, but *G. conglomerata*, a subtropical and sub-Antarctic species, is more abundant than in the Drake Strait, and becomes dominant at some of the stations above 70° S. A long list of species could be compiled. At one of the most southern stations, WS 505 in 70° 10′ 30″ S, the following species were recorded, all denizens of warmer water: *Bolivina cincta*, *B. decussata*, *B. spinescens*, *Cassidulina subglobosa* (very large), *Globigerina bulloides*, *G. dutertrei*, *Gaudryina flintii*, *Lagena laureata*, *Verneuilina bradyi*, *V. bradyi* var. *nitens* (not found otherwise except in Drake Strait and Scotia Sea), and *Virgulina schreibersiana* var. *complanata*. *Hyperammina novae-zealandiae* at St. WS 515, and *Gaudryina ferruginea* at St. WS 516, are in themselves strong evidence of Pacific influence. The best and largest specimens of *Cibicides wuellerstorffi* were found at St. WS 505, the only other records being in the Drake Strait and Scotia Sea, while *Epistomina elegans*, known otherwise only from one small specimen at St. WS 469 on the convergence, yielded two very large individuals at St. WS 505, which appears to be its most southern record.

SOUTH GEORGIA AND ITS ISOLATED FAUNA

The preparation of a separate report for the Foraminifera of South Georgia was, in its inception, purely a matter of convenience, as the island lies within the Antarctic convergence line, and its fauna might have been expected to be similar to that of the regions farther to the south. But the amount of Antarctic material already received, to which additions were continually being made, was so large that it was felt to be impossible to deal with it as a whole. It was decided to divide the Antarctic report into two parts, and South Georgia being in itself rather an isolated area, naturally formed a section. The course followed has proved to be fortunate, for South Georgia, instead of being a homogeneous factor with the rest of the Antarctic area, has been found to possess a foraminiferal fauna differing in many respects from that of the adjacent islands. The full extent of this difference had not been realized when I drew attention to its existence on p. 31 of the South Georgia report.

This difference is no doubt partly due to the peculiar nature of its shallow-water bottom deposits, which generally speaking are tenacious muds of terrigenous origin and loaded with diatoms, thus forming a particularly rich feeding ground for the large mud-eating species. By contrast, the shallow-water deposits of the South Sandwich, South Orkney and South Shetland groups are coarse and sandy, often of volcanic origin, and deposits of mud are infrequent. But it seems probable that current action is more responsible for the distinctive nature of the South Georgian fauna. The island, cut off by deep water from all the adjacent groups, is practically encircled by cold Antarctic water sweeping up from the Weddell and Bellingshausen Seas, while the warmer Pacific water passes to the north of the island, after influencing the fauna of regions farther south. The foraminiferal fauna of South Georgia therefore remains isolated, and to some extent preserves an Antarctic facies which the southern areas are losing. Species of distinctly Pacific origin are very few in comparison with their number in higher latitudes. In its isolation, South Georgia has either preserved or developed species which are almost confined to the island. Thus its most characteristic species, *Ehren-*

bergina crassa (SG 193), recorded from fifty stations in South Georgia and often very common, is represented in the rest of the Antarctic material by a single specimen, which I am inclined to regard as a "stray". Its place in the southern areas is taken by a comparatively small, but structurally closely allied form, *Ehrenbergina parva* (No. 298), which was not found in South Georgia. It is difficult to resist the theory that *E. parva* was the original Antarctic species which, in the isolation and richer feeding ground of South Georgia, has developed into the large and stoutly constructed *E. crassa*. Again *Ammobaculites bargmanni* (SG 118), the largest species of its genus, and *A. rostratus* (SG 119) are both typical South Georgia species of not infrequent occurrence. Neither of them has been found in the southern material. *Armorella sphaerica* (SG 71 and No. 98), recorded from twelve stations in South Georgia and at times common, occurs at seven stations among the island groups, but except at one station is always rare. *Hippocrepinella hirudinea* (SG 82 and No. 114), recorded at thirteen stations and abundant in Cumberland Bay, is extremely rare at the three stations from which it is recorded in the Antarctic. *Gordiospira fragilis* (SG 33 and No. 41), recorded from six stations and common at several of them, was found at one station only, off the South Orkney Islands. Other instances could be given, but these are sufficient to show that South Georgia has an Antarctic fauna of a peculiar and isolated description.

A comparison of the South Georgia list with the present report shows that its 345 species and varieties include more than sixty which were not recorded in the southern areas. But too much stress should not be laid upon these deficiencies, as many of them are small shallow-water forms favouring a muddy habitat, and therefore less likely to occur in the coarser and generally deeper material from the Antarctic. Conversely it is well to mention one of these smaller species which has a very different distribution in the two areas. *Trochammina bradyi* (F 111, SG 137 and No. 196), a small but distinctive species, was recorded from sixty-five stations in the Antarctic, and is often one of the commonest forms, especially in the Bransfield Strait area. But in South Georgia it was recorded as "very rare" at only three stations, all on the north or "Lee" side of the island, as the currents run. So it is not easy to avoid thinking that the species is of comparatively recent introduction to South Georgia, and has not yet established itself there. A single specimen was found in the Falklands area. The known distribution of *T. bradyi* is peculiar: it is not uncommon in British dredgings and generally on the eastern shores of the North Atlantic, but Cushman says that it is not found on its western shores. The 'Terra Nova' recorded it in the Ross Sea, and Sidebottom from deep water on the east coast of Australia. The Discovery specimens may have been derived from either of these southern centres of distribution, as Wiesner does not record it off Kaiser Wilhelm's Land, and I do not remember any other published records.

PREVIOUS WORK IN THE AREA

Many expeditions have traversed the regions under survey but, so far as I am aware, only two reports on Foraminifera collected by them have been published.

THE POURQUOI PAS? EXPEDITION

Charcot in his second voyage in the 'Pourquoi Pas?', 1908–10, visited Graham Land, the Biscoe Islands, Queen Adelaide Island, Alexander Land and the coast named after him Charcot Land. Much collecting was done, but does not appear to have extended to Foraminifera. At any rate the material must have been of the scantiest, as Fauré-Fremiet records only these fourteen species in his reports (F. 1913–14, FMAF).

No. in this report	
127	*Rhabdammina discreta*, Brady
?156	*Reophax distans*, Brady = ?*Hormosina ovicula* var. *gracilis*
140	*Reophax dentaliniformis*, Brady
158	*Haplophragmium canariensis* (d'Orbigny)
166	*Haplophragmium latidorsatum* (Bornemann) = *H. subglobosus*
—	*Miliolina alveoliniformis*, Brady
259	*Bulimina aculeata*, d'Orbigny
286	*Cassidulina crassa*, d'Orbigny
?269	*Virgulina subdepressa*, Brady = *V. schreibersiana* probably
340	*Entosolenia globosa*, Ehrenberg
452	*Uvigerina pygmaea*, d'Orbigny
454	*Uvigerina angulosa*, d'Orbigny
?464	*Globigerina bulloides*, d'Orbigny = *G. pachyderma* by the figure
	Truncatulina?

Fauré-Fremiet's most interesting record is the arenaceous form which he figured and assigned, with reservations, to *Miliolina alveoliniformis*, Brady. It is not that species but a *Miliammina*, the first of its genus to be figured. Some observations on his record will be found on p. 90 of the South Georgia report. I can only add that after examining material from most of the areas visited by the 'Pourquoi Pas?', I have found no specimens resembling Fauré-Fremiet's organism in possessing a cribrate aperture. *Miliammina cribrosa*, H.-A. and E., as it has been renamed, remains a "ghost" species, based only on a figure, the types being missing.

THE SCOTIA EXPEDITION

The Scottish National Antarctic Expedition, 1903–4, in the 'Scotia', under Dr W. S. Bruce, worked down from the Falklands, through the South Orkneys into the Weddell Sea, with many stations down to the shores of Coats Land in about 74° S. A report on the Foraminifera was published by F. G. Pearcey (P. 1914, SNA) who described a rich fauna, especially Arenacea, increasing in size and abundance on the continental slopes. Pearcey lists 267 species of which eleven were new. Unfortunately his report, in common with the reports of the Terra Nova and Gauss Expeditions, deals also with material from stations outside the Antarctic area, and considerable labour is entailed in separating Antarctic from other records. Twelve of the Scotia stations are in the Weddell Sea and off the shores of Coats Land. He reports that the foraminiferal fauna of the Antarctic is richer south of 70° S than north of that line. This may be true of the Weddell Sea, where physical conditions are not identical with those in the Bellingshausen Sea, but it would not apply to the area covered by this report. Foraminifera are most abundant, both as regards species and specimens, in the Discovery region between 60° and 65° S, and there is a distinct falling off in both respects in most of the gatherings received from south of 65°.

An analysis of Pearcey's report shows that he records eighty-three species or varieties from Weddell Sea stations. Sixty-five of these figure in the present report, a few of them under other names when Pearcey's nomenclature is out of date. The eighteen species which I have not met with are:

Keramosphaera murrayi
Astrorhiza arenaria
**Syringammina minuta*
Rhabdammina cornuta
Rhizammina indivisa
Saccammina socialis
Technitella raphanus
**Technitella asciformis*
**Thurammina favosa* var. *reticulata*
Aschemonella catenata
**Reophax robustus*
Hormosina normani
**Hormosina irregularis*
**Haplophragmoides umbilicatum*
**Cyclammina contorta*
Gaudryina pseudofiliformis
Truncatulina tenuimargo
Anomalina polymorpha

Seven of the foregoing, marked with an asterisk, are described as new species, some from single specimens. Of the remainder several are open to suspicion as to their identity, e.g. *Technitella raphanus*, Brady, known previously only from a Challenger record at Fiji. It seems possible that this was *Hyperammina novae-zealandiae*, H.-A. and E. (No. 119), which externally bears some resemblance to Brady's species, and occurs in the Discovery material. On the other hand, Wiesner describes and figures a specimen from Kaiser Wilhelm's Land under the name *Technitella raphanus*, Brady, which is not very much like Brady's figure, but is certainly not *H. novae-zealandiae*. It would be interesting to compare Pearcey's and Wiesner's specimens with the original type. *Gaudryina pseudofiliformis* was possibly *G. apicularis* (No. 243). *Haplophragmoides umbilicatum* seems inseparable from *H. rotulatus* (No. 168). The most interesting record of all is *Keramosphaera murrayi*, known until then only from a few specimens dredged by the 'Challenger' in 53° 55′ S, 108° 35′ E, 1950 fathoms, i.e. nearly due south of Cape Leeuwin in Australia. Wiesner (W. 1931, FDSE, p. 111, pl. xvii, figs. 199, 200) has recently recorded *Keramosphaera*, but his specimens also were found in the Indian Ocean (65° 15′ S, 80° 19′ E), and but for the fact that Pearcey had worked in the Challenger office and from his own statement was familiar with the types, his record would be suspect. Pearcey's record of *Keramosphaera* marks a notable extension of the range of this rare and interesting genus, and its occurrence at these widely separated localities, combined with its absence elsewhere both eastwards and westwards, may be regarded as evidence that the Antarctic includes two distinct regions, separated from each other by Graham Land on the west, and some unknown line to the E of the Kerguelen Plateau on the east.

Perhaps the most significant feature in Pearcey's list is the absence of *Miliammina*. He does not record any arenaceous species of *Miliolina*, as no doubt he would have called it. Nor does any species of *Miliammina* figure in the few Discovery lists from the

Weddell Sea (Sts. WS 552, 553, 555). At the same time it would not be safe to assume its absence on so few records.

I have unfortunately not been able to examine Pearcey's specimens,[1] but there are a few mounts by him in the Heron-Allen and Earland collection in the British Museum (Natural History) which have proved interesting as paratypes. Of these a fragment of *Syringammina minuta* is quite unidentifiable as a Foraminifer. A large and perfect specimen referred to *Technitella asciformis*, and in general agreement with the figure of the type, is certainly not a *Technitella*. The test appears to be chitinous, or perhaps fibrous, without sponge spicules and not agglutinate. Its nature is obscure and I doubt whether it is a Foraminifer at all. It may be an egg-sac of some organism. The specimens of *Reophax robustus* are principally *R. pilulifer*, but a few resemble his figure and may be regarded as *Hormosina*. The mounts of *Hormosina irregularis* are abnormal and distorted individuals of *H. globulifera*. *Haplophragmium umbilicatum* is only a large and coarsely-built form of *Haplophragmoides rotulatus*.

The sixty-three species common to this report and to Pearcey's are, with few exceptions, deep-water cosmopolitans. His small total of eighty-three species indicates that the Weddell Sea has not a particularly abundant or varied foraminiferal fauna, that the majority are species of cosmopolitan deep-water character, and that his rare or new species do not extend their range westward into the Bellingshausen and Scotia Seas, or to the island groups in those seas. In short that, apart from such cosmopolitan species, the Weddell Sea fauna has little in common with the fauna found to the west of a line running from the extremity of Graham Land through the South Orkneys to the South Sandwich Islands. This isolation of the Weddell Sea fauna would be accounted for if there had been a separation of the two areas by a land surface within comparatively recent geological times, as seems to be indicated by the lines of soundings confirming the theory of the Scotia arc. Since the disappearance of this land barrier, the northward sweep of the Weddell Sea current appears to have been sufficient to maintain the isolation of the fauna, and to prevent the incursion of those warmer water species which have established themselves to the westward of the old land barrier. There is practically no evidence of Pacific influence, except the record of *Technitella raphanus*, to be found in Pearcey's list, and none in the few Discovery records from the Weddell Sea.

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[1] Pearcey's types and station slides from the 'Scotia' are apparently lost. I visited Edinburgh, expecting to find them in the Royal Scottish Museum, where the collections made by the late Dr W. S. Bruce are preserved, but after exhaustive search Dr A. C. Stephen was unable to find any trace of the Foraminifera having been received with the other collections. Inquiry made in various quarters, including the Bristol and Manchester Museums, where Pearcey had been employed, also failed to give any trace. After Pearcey's death, Mr E. Heron-Allen purchased a small collection of Foraminifera from his representatives, including some mounts from 'Scotia' stations, but they are obviously not the working slides on which his report was compiled. It is thought that Pearcey may have disposed of the slides in his lifetime to some collector or Museum, in which case it is to be hoped that they will eventually be restored to their proper place in the Royal Scottish Museum.

PREVIOUS WORK IN OTHER SECTORS OF THE ANTARCTIC

A good deal of research has been undertaken in Antarctic localities outside the Falklands sector, a summary of which to the year 1922 will be found on pp. 28–9 of the Terra Nova report (H.-A. and E. 1922, TN). No separate report on the Foraminifera discovered by the British Discovery Expedition, 1901–4, was published, but a certain amount of material was examined by Heron-Allen and Earland. The results are incorporated in the Terra Nova report, *passim*, and on pp. 233–5 of that report.

THE TERRA NOVA EXPEDITION

The report on this expedition deals with the sector of the Antarctic between New Zealand and the Ross Sea, and includes a great many stations in the south-west Pacific extending from the northern extremity of New Zealand down to the Ross Sea. Apart from the labour of separating records from such widely diverse areas, is the further difficulty that it is very deep water all the way from the continental slope of New Zealand to the corresponding Antarctic slope, which is well within the ice region. As the foraminiferal fauna of deep water is very similar in all oceans, and identical in many respects with the fauna of shallower water in high latitudes, it is really impossible to draw a line and say where the Terra Nova Antarctic region begins. I do not know the position of the Antarctic convergence in this area, which might have been some guide. For purposes of comparing the fauna of the Terra Nova report with that of the Falklands sector of the Antarctic, I have therefore taken all stations which lie outside the New Zealand continental slope, i.e. the H.-A. and E. Sts. 13–55 inclusive. These include many stations which are entirely outside the Antarctic, but being in very deep water their fauna, apart from pelagic species, will be of a cold-water type, and they may be regarded as balancing those deep-water Discovery stations which also, strictly speaking, are outside the Antarctic.

On this basis I estimate that there are 369 Antarctic species and varieties recorded in the Terra Nova report. Of these 280 figure under the same or an amended name in this report, and nineteen others in the South Georgia report but not in this. Of the remainder it may be said that, apart from special rarities, including new species and varieties, there are not many which have not a known distribution outside the Antarctic. I think the great similarity between the lists is strong evidence that the Ross Sea, and the deep south-west Pacific to the south of New Zealand, are zoologically a continuous area with the Bellingshausen and Scotia Seas.

Corroborative evidence of this theory is afforded by Chapman's report on Foraminifera from soundings in the Ross Sea (C. 1914, FORS), as out of sixty-four species and varieties described more than fifty are in the Discovery list.

Several of the new species described in the Terra Nova report and by Chapman have been found again by the 'Discovery'. Among them are those given in the table on p. 14.

This might be regarded as very strong or even conclusive evidence of the zoological identity of the areas, but for the fact that five of the six species marked with an asterisk have been recorded by Wiesner from Kaiser Wilhelm's Land. These five species appear to have a more or less completely circumpolar distribution. Of the distribution of the sixth species *Hyperammina novae-zealandiae*, reported by Wiesner off the Cape of Good Hope, I have written elsewhere (p. 18).

No. in Discovery reports		Name	No. in Terra Nova report	Area where first discovered
SG 149–51	216–19	*Miliolina oblonga* var. *arenacea*	34	Antarctic
	65	*Dendronina arborescens* var. *antarctica*	75	Antarctic
	66	*Dendronina limosa* var. *humilis*	77	Antarctic
F 75, SG 87	119	**Hyperammina novae-zealandiae*	96	New Zealand
	142	*Reophax longiscatiformis*	111	Antarctic
	245	*Gaudryina ferruginea*	200	New Zealand
	282	**Bulimina chapmani*	233	Antarctic
	232	**Bolivina punctata* var. *arenacea*	242	Antarctic
F 165, SG 192	296	**Ehrenbergina hystrix* var. *glabra*	275	New Zealand & Antarctic
	322	*Lagena clavulus*	292	Antarctic
	366	**Lagena marginata* var. *fissa*	339	Antarctic
	387	*Lagena scottii*	315	Antarctic
F 196 A, SG 244	396	**Lagena squamoso-sulcata*	317	Antarctic
	400	*Lagena stelligera* var. *nelsoni*	306	Antarctic
	381	*Lagena quadrangularis*, Brady (now renamed)	353	Antarctic
	348	*Lagena striatopunctata* (pars) Parker and Jones (now renamed)	309	Antarctic
F 258		*Nodosaria pellita*	408	New Zealand
SG 302	484	*Discorbina wilsoni*	543	Antarctic

THE GERMAN SOUTH POLAR EXPEDITION, 1901–3

The 'Gauss' under von Drygalski wintered in the ice off Kaiser Wilhelm's Land in about 66° 2′ S, 89° 38′ E. The report on the Foraminifera was not published until 1931, the long delay being due partly to divided authorship. Rhumbler, who commenced the examination of the material, could not find time for its completion, and handed his observations including some new genera and species to Wiesner, by whom the work was completed and issued. The report deals with the entire voyage of the 'Gauss' out and home, via Kerguelen Island, and is therefore a mixed bag of tropical, subtropical, sub-Antarctic and Antarctic species. As there is neither map nor station list in the report the separation of the faunas is not easy. An earlier report (E. Philippi, *Die Grundproben der Deutschen Süd-polar Expedition*, 1910, German South Polar Reports, II (6), pp. 411–616) shows that Sts. 47–72 lie on the Antarctic continental shelf and slope, while Sts. 73–86 are on the floor of the Indo-Antarctic basin, and owing to their depth and latitude (lowest latitude, 62° 4′ S) may be regarded as genuinely Antarctic.

With this information as a guide I made an analysis of Wiesner's records. Of the 371 species and varieties, 216 were found on the continental shelf and slope, and fifty-two others in the deep water of the Indo-Antarctic basin, but not on the slope. The balance are sub-Antarctic (Kerguelen, etc.), tropical (Cape Verde) and pelagic.

An exact comparison of the Gauss, Terra Nova and Discovery faunas would be very difficult without an examination of the Gauss specimens, owing to differences in classification and nomenclature. But it is very apparent that the foraminiferal fauna of Kaiser Wilhelm's Land has more points of difference than agreement with that of the Falklands sector of the Antarctic, or that of the Ross Sea. There are of course a great many species common to all three areas, the majority being of world-wide distribution in deep water. There are also a limited number of species known only or principally from Terra Nova records, and found again in Discovery material. Among these are *Vanhoeffenella gaussi* (No. 51), *Pseudobulimina chapmani* (No. 282), *Textularia antarctica* (No. 232), *Ehrenbergina hystrix* var. *glabra* (No. 296) and *Lagena squamoso-sulcata* (No. 396). The range of these species therefore extends over more than half the south polar circumference, and it might be presumed that they had a circumpolar distribution but for the fact that none of them has been recorded in the Weddell Sea, and that there are at present hardly any records for Foraminifera between the Weddell Sea and Kaiser Wilhelm's Land.

Of the 268 species and varieties recorded by Wiesner from the Antarctic, I have traced 149 in the Discovery list, not always under the same specific or generic name. This may seem quite a high proportion, but the majority, certainly 100 of them, are species of very wide or world-wide distribution. On the other hand, very few of the sixty or more Antarctic species and varieties described as new can be identified in the Falklands sector of the Antarctic. The exceptions are:

No. in Discovery reports	Wiesner's name	Recorded from
SG 122 and 176	*Ammomarginulina ensis*	South Georgia and Antarctic
265–6	*Delosina complexa* (2 species figured under one name)	Both in Antarctic
157	*Hormosina lapidigera*	Antarctic
131	*Hospitellum manumissum*	Antarctic
407	*Lagena texta*	Antarctic
SG 81 and 113	*Technitella flexibilis* (= *Hippocrepina*)	South Georgia and Antarctic
SG 64 and 86	*Saccammina tubulata* (= *Proteonina*)	South Georgia and Antarctic
82	*Psammophax consociata*	Antarctic
232	*Pseudobolivina antarctica* (= *Textularia*)	Antarctic
SG 67 95	*Tholosina laevis*	South Georgia and Antarctic
89	*Urnula quadrupla*	Antarctic
235	*Verneuilina bradyi* var. *nitens*	Antarctic
240	*Verneuilina minuta*	Antarctic

At least some of these may be found eventually to have a distribution outside the Antarctic in cold areas and deep water. I think the balance of evidence indicates that the foraminiferal fauna of Kaiser Wilhelm's Land is not closely connected with the faunas of the Ross Sea and Falklands sectors of the Antarctic.

The most recent addition to the literature of Antarctic Foraminifera is a short paper, "Foraminifera from the Ross Sea", by A. S. Warthin, Jnr. (*Amer. Mus. Novit.*, No. 721, May 4, 1934). The material examined was a single sounding of 200 cc. grey mud from 280 fathoms in the Bay of Whales, Ross Sea (78° 34′ S, 163° 48′ W). The locality is stated to be the most southerly point at which Foraminifera have been collected, and the only station of its kind in the eastern Ross Sea. It is on the continental shelf, about 90 miles from the nearest known land and approximately in the same area as some of the Terra Nova stations.

The sample left a residue of nearly 3 cc. containing in order of abundance, Foraminifera, Radiolaria, sponge spicules, Alcyonarian spicules, and worm tubes. 350 identifiable specimens of Foraminifera were picked out and referred to thirty-six species, two being new—*Trochammina rossensis* and *Cyclammina gouldi*. Neither of these can be identified as occurring in the Discovery material. Twenty-nine of the species appear under the same specific names in this report.[1] Of the five remaining forms, two are not identified specifically, *Saccorhiza* sp. and *Gaudryina* sp.; *Marsipella elongata*, Norman, is cosmopolitan; *Haplophragmoides umbilicatus*, Pearcey, is only a large and coarsely built form of *Haplophragmoides rotulatus* (Brady) (No. 168); and *Trochammina turbinata* (Brady) may be either the form described in this report as a new genus and species, *Recurvoides contortus* (No. 169), or *Trochammina inconspicua*, sp.n. (No. 199).

The sounding may be taken as an average specimen from the Antarctic continental shelf in its proportion of organic to inorganic remains, and in its constituent species and their number in specimens; it could be duplicated from the Discovery and Terra Nova stations, and the results amply confirm the existence of an almost identical foraminiferal fauna on the continental shelf, from Graham Land to the most distant points known in the Ross Sea.

One statement made by the author cannot pass unchallenged. He says that "within 60 miles of the coasts of Antarctica and the larger sub-Antarctic islands, the calcareous species despite the coldness of the water are the predominant element in the fauna. This condition prevails to depths of 2000 ft., beyond which point we have little evidence at the present time. Farther off-shore in similar depths, the agglutinated species become the more abundant forms. The change in relative abundance results partly from an actual increase in the agglutinated forms, but chiefly from the almost complete elimination of the Lagenidae and Rotaliidae at the greater distances".

This is entirely at variance with my experience as regards both the Terra Nova material from the Ross Sea and the Discovery material. Disregarding those stations where the *Globigerinae* occur in such number as to mask other organisms (as in the Drake Strait and some stations in the Bellingshausen Sea), the calcareous species play an insignificant part in Antarctic material from whatever depth. In number of species they may exceed the arenaceous and agglutinate forms, but the calcareous species are with very few exceptions always represented by few individual specimens, and apart from *Globigerina* oozes the facies of an Antarctic gathering is always arenaceous.

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[1] Nos. 70, 108, 122, 133, 140, 141, 145, 148, 158, 162, 166–7, 180–1, 189, 193, 195, 197–8, 216, 229, 231, 234, 288, 464, 487, 513–15.

PACIFIC INFLUENCE IN THE ANTARCTIC

The presence of species of Pacific origin was observed and commented on in the Falklands report (p. 297). They were almost entirely lacking in South Georgia, *Hyperammina novae-zealandiae* and *Bolivina decussata* being the only noticeable records. But as soon as the Antarctic records were analysed it became evident that many species were being found which had no previous Antarctic history, yet were known from Australian and New Zealand areas.

The genus *Lagena* offers the greatest number of instances, probably because it is by far the largest genus, with several hundred so-called species, many of which are at home in all latitudes and at all depths. Others having a very limited distribution form suitable subjects for comment. Fortunately we know a great deal about the *Lagenae* of deep water in the south-west Pacific, Sidebottom having published two papers (S. 1912, etc., LSP) illustrating the *Lagenae* found in soundings made by H.M.S. 'Penguin', 'Waterwitch' and 'Dart' in the area between 3° 51′ to 43° 05′ S and 149° 39′ E to 158° 21′ W. He figures and describes about 180 species and varieties including many novelties, some of which are known only from his papers. At least seven of his new forms are to be found in Discovery material, besides many others which he records from the south-west Pacific, but which are also known from other localities. The seven are:

Discovery no.	
305	*L. alveolata* var. *separans*, also recorded at the Falklands (F 246)
311	*L. auriculata* var. *arcuata*
324	*L. compresso-marginata*
375	*L. orbignyana* var. *unicostata*, also recorded by Terra Nova (No. 366) from the Antarctic
399	*L. stelligera* var. *eccentrica*, also recorded by Terra Nova (No. 305) from New Zealand, the Antarctic and Tierra del Fuego
404	*L. striatopunctata* var. *complexa*
411	*L. virgulata*

While dealing with the genus *Lagena* it is instructive to compare the Discovery species with those recorded by the 'Terra Nova'. Disregarding the species known to have a wide distribution I find many common to the two lists.

Discovery no.		Terra Nova no.	Recorded from
307	*L. ampulla-distoma*	290	New Zealand
322	*L. clavulus*	292	Antarctic, also recorded as *L. aspera* var. by Sidebottom
348	*L. heronalleni*	309	Antarctic, recorded by Terra Nova as *L. striato-punctata*, P. and J. (pars)
366	*L. marginata* var. *fissa*	339	Antarctic, also recorded by Wiesner
373	*L. multicosta*	303	Antarctic
376	*L. ovum*	283	Antarctic
381	*L. quadrilatera*	353	Antarctic, recorded by Terra Nova as *L. quadrangularis*, Brady
387	*L. scottii*	315	Antarctic
396	*L. squamoso-sulcata*	317	Antarctic, also recorded by Wiesner
399	*L. stelligera* var. *eccentrica*	305	New Zealand, Antarctic, Tierro del Fuego
400	*L. stelligera* var. *nelsoni*	306	Antarctic

A very interesting record among the Discovery *Lagenae* is *Lagena globosa* var. *tenuissimestriata*, Schubert (No. 343), known previously only from a fossil *Globigerina* ooze (Miocene) in the Bismarck Archipelago, New Guinea. It was found at two stations in the Bransfield Strait region.

Cushman has recently published a report (C. 1932, etc., TPA) on the Foraminifera of the Tropical Pacific collections of the 'Albatross'. The course of the ship ran approximately down the meridian of 140° W from 20° N to 20° S, then along the parallel of 20° S to 180° W then N and NW to 150° E, covering both deep and shallow waters. He records over thirty species and varieties of *Lagena* but, with the exception of *L. ampulla-distoma*, which is a not uncommon species in Indo-Pacific shallow waters, none of the foregoing forms and very few of Sidebottom's south-west Pacific species are in his list. It seems obvious therefore that the central Pacific fauna has very little in common with that of the south-west Pacific, and that the Pacific species found in the Antarctic originated in the more distant south-westerly region of that ocean.

There are a few species belonging to other genera which support this theory. *Gaudryina ferruginea*, H.-A. and E. (No. 245), a very distinctive little species, was described in the Terra Nova report from off the North Cape, New Zealand, in 70 fathoms, where it was not uncommon, but it was not found in the Ross Sea. It had not been recorded from any other locality until it was rediscovered at three stations spread over the Drake Strait, Scotia Sea and Bellingshausen Sea. The specimens are quite typical except that they are rather neater in construction owing to the finer sand used, a change due to the deeper water, 2611–3744 m.

Hyperammina novae-zealandiae, H.-A. and E. (No. 119), a very strongly defined species, was described as abundant at the same Terra Nova Station in New Zealand, but was not found in the Ross Sea. It turned up again in the Falklands area and in South Georgia, and may be present in the Weddell Sea (see p. 11 *ante*). Now it is recorded from the Bellingshausen Sea. Its range extends much farther to the east, for Wiesner records it as "typical", off the Cape of Good Hope, and "sandy" (which may not be the same organism) still farther east near the Crozet Islands. I cannot recall that the species has been recorded elsewhere, and it is difficult not to associate such a circumpolar distribution with the West Wind Drift.

Ophthalmidium margaritiferum, H.-A. and E. (No. 44), also discovered at the same Terra Nova station, occurs as a single specimen at St. 177 in the Bransfield Straits.

Cassidulina elegans, Sidebottom (No. 290), is a rare but very distinctive species originally found in one of the 'Waterwitch' soundings in the south-west Pacific, and known only from other soundings taken in the north-west Pacific between Guam and Japan. A few perfectly typical specimens have been found in the deep water of the Drake Strait within the Antarctic convergence.

Cassidulina pacifica, Cushman (No. 291), is known under the name *Cassidulina calabra*, Brady *non* Seguenza, from many records in the Indo-Pacific and south-west Pacific regions. It occurs at two stations in the Drake Strait within the convergence, and Pearcey records it from the Burdwood Bank. It is found fossil in the Pliocene of California.

Bolivina decussata, Brady (No. 281), was described from a Challenger station off Juan Fernandez Island in the south Pacific. Cushman records it with some reservations from off Japan. A few typical specimens were found in South Georgia, and single specimens are now recorded from three stations, two being in the Drake Strait outside and just within the convergence, and the third in the far south of the Bellingshausen Sea. This last record seems clear evidence of an inflow of Pacific water into that sea.

Bolivina spinescens, Cushman (No. 274), is known from several records spread over the Indo-Pacific and south-west and central Pacific regions. It was found in some numbers in the Falklands area but not in South Georgia. Quite typical specimens were found at four stations in the far south of the Bellingshausen Sea. The 'Terra Nova' recorded it from both New Zealand and the Antarctic.

Virgulina schreibersiana var. *complanata*, Egger (No. 270), was first recorded from the west coast of Australia, and subsequently from the east coast by Sidebottom. It is possibly distributed over the Indo-Pacific region but has not been separated by authors. It occurs at no less than seventeen stations spread over the whole area of the present report, with depths ranging between 100 and 4344 m.

I think these few instances are sufficient to prove an extension of the range of species in an eastern direction across the south Pacific. Many other instances will be found in the preceding pages of the report and in the notes on species.

DISTRIBUTION OF FORAMINIFERA

It is much easier to provide evidence of such extension of range, or migrations of benthic species, than to explain how they have come about. Yet we have to find some explanation of the presence of these alien organisms in Antarctic waters. Several theories present themselves, none of which is entirely satisfactory; perhaps the solution may be found eventually in a combination of them.

(1) *Geological survival*. These warmer water species may be the survivors from a geological time when coast-lines and climate were different, and a warm-water fauna existed right across the south Pacific from the Australian coast. I am no geologist but understand that there is evidence of the former existence of a warm climate in Antarctica. In such case it is quite reasonable to suppose that a few forms might be more adaptable to changes of environment than the majority of their fellows, and survive where other species died out.

Perhaps the strongest piece of evidence in support of this theory would be the case of *Rotalia clathrata*, Brady, which is a very common species in shallow water on the coasts of Australia and New Zealand. Geologically it has a history extending back to at least Miocene times in Victoria. It is found to-day on the west coast of Patagonia and in the Falklands (F. 395 and p. 297). But if it was ever domiciled on the Antarctic coast-line it has not adapted itself to polar conditions and has disappeared.

(2) *Movements of Foraminifera*. Given the practically unlimited time furnished by

geological history, it is possible that the alien species may have migrated solely by their own capacity to travel, although the powers of locomotion in the Foraminifera are of the poorest kind, so slow as to be almost non-existent. From my own observations I should put an inch in a day as an average limit of active individuals. Many appear to remain in the same position on the sides of an aquarium without movement for days on end, and of course a great many forms are sessile and cannot move from their environment. Cushman (C. 1933, F, pp. 6–7) gives higher speeds for several species, up to 12 mm. an hour, but the observations were made in the Tortugas, where warmth may stimulate movement. He also gives an average speed of 1 cm. an hour for *Iridia diaphana*, Heron-Allen and Earland. But this is a sessile arenaceous form, and the movements were those of the naked protoplasm after the organism had left its test, perhaps in protest against detachment from its base, and cannot be regarded as evidence of any normal movement or habit. Upon this observation, which so far as I am aware is the only record of the abandonment of its test by a Foraminifer, Cushman surmises that the animals leave their tests at will, and wander in search of new material to construct a fresh test. The theory has no evidence in its support, except his single observation on specimens artificially removed from their environment, and seems unnecessary, as wave action in shallow waters, and in greater depths the disturbance of sediment by other organisms, would furnish fresh supplies of building material.

However, given an unlimited time factor, there is no reason why even these "slow-motion" organisms should not travel enormous distances by their own powers and volition, and this may have been the means by which the numerous cosmopolitan species have obtained a habitat in nearly all seas. But the theory fails to explain why these particular forms which we are considering migrated only in an easterly and south-easterly direction, instead of radially from the starting-point, as might have been expected; unless there was at one time a land barrier which stopped their progress into the central Pacific and confined them to an easterly direction. If geologists confirm such a barrier, the theory of migration by their own power of movement may be accepted as sufficient to meet the facts of the case.

(3) *Transportation by surface currents.* These, in the form of the West Wind Drift, are no doubt responsible for the distribution of pelagic species. They account for the presence of *Globigerina triloba* at many stations right down to the south of the Bellingshausen Sea. The species was not found by the 'Terra Nova' in the Ross Sea, though Chapman recorded "one specimen" there. Pearcey did not find it in the Weddell Sea, or Wiesner off Kaiser Wilhelm's Land except in one pelagic record. But nearly all Foraminifera are benthic organisms, and cannot be transferred in the adult stage at least by surface currents. Any deep-sea currents are, I take it, too feeble to give assistance.

Could the Foraminifera be transported by surface currents while still in an immature condition? In the life history of those few species which have been worked out there are two forms, the megalospheric and microspheric, and the megalospheric form generally reproduces by the formation of motile zoospores which conjugate and settle down as microspheric individuals. This is obviously a method of reproduction favourable to wider distribution than the asexual reproduction of the microspheric individual. In this latter case the young organism is born in the proximity of the parent, forms a test, and is thereafter dependent solely upon its own powers of movement.

The megalospheric and microspheric forms can be found in a great many genera of whose life history we know nothing, but it seems logical to suppose that a similar mode of reproduction occurs in them, and perhaps in all Foraminifera. In such case the zoospores will be at the mercy of currents. Of their viability, i.e. of the length of time during which they survive if they fail to conjugate, we know absolutely nothing, but presumably it would be only a short period of hours, or days at most. But if, like a great many similar organisms, these zoospores have the power to pass into a resting-spore condition, they might well be transported for long distances, in a living state.

Wayland Vaughan (V. 1933, BROF) has recently published a very suggestive paper in which he attempts to explain the migrations of the large Orbitoid Foraminifera between Europe and America in Upper Cretaceous times by a zoospore theory. He suggests that the zoospore stage was transported by currents and, given a viability equal to that of the free-swimming larval stages of some corals, up to 30 days, would at intervals across the Atlantic find banks and submarine peaks on which they could develop into mature individuals before starting on a fresh stage of the voyage again as zoospores. He concludes (p. 935, *op. cit.*) "that the facts of the known geographic distribution of the Orbitoid Foraminifera, during successive geological epochs, can be accounted for by the transport of the organisms during larval stages by ocean currents, and that the postulation of the former existence of extensive land areas where there are now oceanic waters of abyssal depths is not necessary. The maximum required change in the depths of the ocean would be that some of the sub-oceanic peaks and ridges should have stood near sea level, but it is not certain that even such changes were necessary". Wayland Vaughan points out that the unknown factor in the problem is the duration of life of the zoospores, and does not invoke the aid of a resting-spore condition to prolong the duration of life.

With the data of submarine banks and peaks which he gives, his theory seems feasible enough so far as the Atlantic is concerned. But I doubt whether it would be tenable as regards the South Pacific, unless the viability of the zoospore were indefinitely extended by a resting stage. Of the existence of such a condition I admit there is at present no particle of evidence, but it seems not impossible, and I hope that the biological work now being done at the La Jolla Institute by Mr Earl H. Myers (M. 1933, MTF) may throw some light on this question. There is no problem connected with the Foraminifera more puzzling, or of greater interest than the occurrence of well-defined species at great distances from their original habitat, especially when, as frequently is the case, the intervening territory is so well known that the presence of the organism could hardly have been overlooked. Such an instance may be found in this report in the case of the species renamed *Botellina goësii* (No. 132).

CIRCUMPOLAR SPECIES

As I have already explained, there are a considerable number of species which have a more or less cosmopolitan distribution. They are principally Arenacea, and are found in all areas of the Antarctic as well as in cold water (which outside the Polar regions means deep water) in all the oceans. Apart from these cosmopolitans, there are a few species which appear to have a complete circumpolar distribution; they have been recorded from widely separated areas, but nevertheless are unknown outside the Antarctic. As they are all recent species, it follows that they must have acquired their universal distribution since the disappearance of the barriers between the areas. It must be presumed that they are more adaptable to changes of environment than the other purely Antarctic species. Among such circumpolar forms are the following, some being quite common, others rare:

No.		
176	*Ammomarginulina ensis*, Wiesner	
265	*Delosina sutilis*, Earland	Recorded by Wiesner under one name *D. complexa* (Side-bottom)
266	*Delosina wiesneri*, Earland	
296	*Ehrenbergina hystrix*, Brady, var. *glabra*, Heron-Allen and Earland	
366	*Lagena marginata*, Walker and Boys, var. *fissa*, Heron-Allen and Earland	
387	*Lagena scottii*, Heron-Allen and Earland (?*L. ornata* (Seguenza) of Wiesner)	
396	*Lagena squamoso-sulcata*, Heron-Allen and Earland	
407	*Lagena texta*, Wiesner	
86	*Proteonina tubulata* (Rhumbler) (*Saccammina tubulata*, Rhumbler of Wiesner)	
282	*Pseudobulimina chapmani* (Heron-Allen and Earland) (*Robertina chapmani* of Wiesner)	
232	*Textularia antarctica* (Wiesner) (*Pseudobolivina antarctica*, Wiesner)	
51	*Vanhoeffenella gaussi*, Rhumbler	
240	*Verneuilina minuta*, Wiesner	

FOSSIL FORAMINIFERA

At St. WS 555 in the Weddell Sea to the south-east of the South Sandwich group (60° 27′ S, 19° 36′ W) in 3850 m. a considerable number of fossil *Globigerinae* were found, but no other fossils. Most of the specimens appear to be solid casts without remains of the original shell, but others are in a better state of preservation. To me they have the appearance of being derived from two sources, a hard chalk or limestone and a softer formation. *Globigerina pachyderma* can be identified and there are probably one or two other species of *Globigerina* present. From the number of specimens in the small sample it would seem probable that the deposit from which they were derived was not distant.

This station would appear to be on the eastern or outer edge of the Scotia arc, if its line is as stated on p. 16 of Macfadyen's report on the fossils from the Burdwood Bank (M. 1933, FFBB).

Very few other fossils were seen. At St. 181 in the Palmer Archipelago, 160–335 m., I found a perfect calcite cast of a *Polymorphina*, probably *Globulina gibba* var. *globosa*, Münster, which Macfadyen has already recorded from the Burdwood Bank (*op. cit.*, p. 4). At St. 170, off Cape Bowles, Clarence Island (61° 25′ 30″ S, 53° 46′ W) in 342 m., several specimens of *Cristellaria* were found. Two, in good condition though rather worn and infiltrated with glauconite, are *Cristellaria gibba*, d'Orbigny, a species found in many deposits and ranging as far back as Cretaceous. The other specimens I have not attempted to identify.

A minute *Bolivinopsis*, which I am unable to identify with any species described, was found at St. WS 472 in the Scotia Sea, 3580 m. It has all the appearance of a Cretaceous fossil.

Owing to Dr Macfadyen's absence from England I have not been able to submit the fossils to him.

CONCLUSIONS TO BE DRAWN FROM THE RECORDS

Combining the information obtainable from already published records of expeditions with the results furnished by the Discovery material, we now have a mass of data bearing on the foraminiferal fauna over more than half of the circumpolar seas. The records begin with the 'Scotia' on the eastern side of the Weddell Sea in about 10° W, and, joining up with those of the 'Discovery', extend more or less continuously to 100° W in the Bellingshausen Sea. Then there is a break until we reach 163° W in the Bay of Whales, from which point we link up with the Terra Nova records extending to about 158° E. Beyond that there is another break until we reach the area of the Gauss Expedition, covering about 95° E–72° E, from which point we have no information except the lists from one or two Challenger stations, until we return to the Weddell Sea. There are thus three large sectors and gaps from which we have no data:

A. 100° W–163° W,
B. 158° E – 95° E,
C. 72° E – 10° W.

A report by F. Chapman and W. J. Parr on the Foraminifera found by Sir Douglas Mawson's expedition is completed but still unpublished. It will contribute something to our knowledge of the gap B.

Meanwhile, on the data we already have, I think the following points may be regarded as proved:

(1) The Weddell Sea foraminiferal fauna is not identical with the fauna of the Scotia-Bellingshausen Seas.

(2) The foraminiferal fauna of the Scotia and Bellingshausen Seas between 25° and 100° W, is identical with the fauna of the Ross Sea between 163° W and 158° E, allowance being made for the development of local species at intervals in such a large area. It follows that the gap A may be considered closed, as we may expect to find a similar fauna existing in the unknown area 100°–163° W.

The Weddell Sea. Pearcey records about eighty-three species and varieties from the Weddell Sea, and the Discovery lists add about thirty to this number, none of particular importance. Even with these additions, it is clear that the Weddell Sea has not a particularly abundant or varied fauna, that the majority are cosmopolitan species, and that Pearcey's rare or new species do not extend into the Scotia-Bellingshausen areas.

Conversely, with few exceptions, forms described from those areas have not extended their range into the Weddell Sea. In short, that, apart from cosmopolitan species, the Weddell Sea fauna has few points in common with the fauna found to the west of a line running from Graham Land through the South Orkneys to the South Sandwich Islands.

What is the reason? There are physical differences in temperature and salinity between the waters of the Weddell and Scotia Seas, but so far as I understand them they are not sufficient to account for the differences in fauna, the Foraminifera on the whole being very tolerant of such slight changes. A more feasible explanation is that the two areas were separated by a land barrier until comparatively recent geological times, and this theory would be supported by the Discovery soundings. These appear to indicate clearly that there was once such a barrier—the Scotia Arc—running in a curve from Tierra del Fuego to the northern point of Graham Land, via the Burdwood Bank, South Georgia, the Clerke Rocks and the South Sandwich, South Orkney and South Shetland groups of islands. Since the disappearance of this barrier (? in Tertiary times), the Weddell Sea current sweeping up the east coast of Graham Land and outwards into the South Atlantic has apparently sufficed to prevent the incursion of Pacific forms into the Weddell Sea. Evidence in support of this may perhaps be found in the absence of *Miliammina* from the Weddell Sea and also from the Gauss area. The genus, which is common right across the Ross-Bellingshausen-Scotia Seas, has extended its range thence, in the line of the West Wind Drift, across the South Atlantic to Tristan d'Acunha and the Cape of Good Hope. There are other forms which are found in the same line of migration, but which have not penetrated into the Weddell Sea.

Eastwards from the Weddell Sea we have no useful records of the foraminiferal fauna across the gap C between 10° W and 72° E, where the Gauss records begin. The fauna described by Wiesner is considerably richer, in its 268 species and varieties, than that of the Weddell Sea, to which however it presents more points of resemblance than it does to the fauna of the Scotia-Bellingshausen-Ross Seas. The absence of *Miliammina*, already alluded to, is a marked point of distinction and others could be quoted. On the other hand, the presence of *Keramosphaera* in the Weddell Sea and in the Gauss material certainly indicates a common origin for the Weddell Sea and Kaiser Wilhelm's Land faunas, the only other record for the genus being the original Challenger discovery intermediate between the two. But we must await information as to the fauna of the gap C, which represents nearly one-quarter of the Antarctic circumference before the identity of the Weddell Sea and Kaiser Wilhelm's Land faunas can be considered to be proved.

I think that I have already supplied sufficient evidence to establish the identity of the foraminiferal fauna over the circumpolar area between 10° W and 158° E going westward, and the principal interest will now lie in determining how much farther to the westward this fauna continues. Somewhere between 158° E, the most westerly point of the Terra Nova material, and 95° E, the most easterly point of the 'Gauss'—or perhaps rather 90° E the most easterly point of the 'Gauss' on the Antarctic continental shelf—I think we shall find evidence of a barrier separating the Kaiser Wilhelm's Land fauna from that of the Ross Sea. That barrier was probably analogous to the Scotia arc, a land connection which at some geological time extended between the Antarctic continent and the continental masses to the north. The report by Messrs Chapman and Parr on material obtained by Sir Douglas Mawson's expedition may do something to establish the position of the dividing line. But it is quite possible that this report may only establish the Ross Sea fauna still farther westward than 158° E, as my friend, Mr W. J. Parr, wrote to me quite recently that "Several of the Mawson stations are close to Gauss station 56 (66° 2′ S, 89° 38′ E) but I do not recognize any of Wiesner's new species". Mr Parr had previously informed me that *Pseudobulimina chapmani* (No. 282) was found in the Mawson material, also that *Proteonina tubulata* (Rhumbler) (No. 86), *Ammomarginulina ensis*, Wiesner (No. 176), and *Textularia tenuissima*, Earland (No. 229), were species which they had described as new, but had lost priority for, owing to delay in publication. But the first three of these four species are known to have a circumpolar distribution and are therefore of no value as evidence of identity in faunas.

CLASSIFICATION USED IN THESE REPORTS

The classification used in the three reports on Discovery Foraminifera is that of H. B. Brady, with such modifications as seem necessary to adapt it to our greater knowledge, and the vast increase in the known genera. In spite of its drawbacks, I regard it as more intelligible and far less complicated than either of the new systems produced in recent years in America.

Since Brady's system was published the Rules of Nomenclature have been established, and under them many of his generic names, after being in use for nearly a century, must give way to earlier names. In the Falklands report *Nonionina*, d'Orbigny, 1826, and *Polystomella*, Lamarck, 1822, were abandoned for *Nonion* and *Elphidium*, both Montfort, 1808. In the present report *Pyrgo*, Defrance, 1824, replaces *Biloculina*, d'Orbigny, 1826, while *Cibicides* and *Eponides*, Montfort, 1808, are used instead of the long familiar *Truncatulina* and *Pulvinulina*. But I am retaining *Miliolina*, *Cristellaria* and *Polymorphina* as comprehensive genera of well established significance.

I have altered the gender of the specific names in some of my genera. This results from correspondence with Dr W. A. Macfadyen before he left England. *Nonion*, for example, which I had always regarded as neuter, being a word of unknown origin, becomes masculine in accordance with its genotype *N. incrassatus*. Dr Macfadyen has since published some notes on the subject which may help to establish unanimity among workers.[1]

ACKNOWLEDGMENTS

I have to acknowledge with thanks assistance received from many workers. Prior to 1933 my former colleague Mr E. Heron-Allen, F.R.S., had picked over a good deal of material. I have indicated with an asterisk in the Station List the thirty-nine station slides which he prepared. He also, in association with Dr Helene Bargmann, made the preliminary working index of species from my identifications of the station slides. To Herr Hans Wiesner I am indebted for confirmation of the identity of several species common to both Discovery and Gauss material, and to Dr L. Rhumbler for information respecting his genus *Astrammina*. Dr J. A. Cushman of Sharon, Mass., Mrs H. J. Plummer of Austin, Texas, and Mr W. J. Parr of Melbourne have helped by supplying paratypes, and other specimens required for purposes of comparison. Dr Hans E. Thalmann of Berne has kindly scrutinized the list of new species for homonyms.

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[1] *On the Correct Writing in Form and Gender of the Names of the Foraminifera.* W. A. Macfadyen and E. J. André Kenny. *Journ. Roy. Micros. Soc.*, London, ser. iii, vol. liv, part 3, September 1934, pp. 177–81.

The station slides, types and all other preparations are deposited in the Heron-Allen and Earland collection at the British Museum (Natural History).

A list of the stations worked over is as follows:

STATIONS MADE BY THE R.R.S. 'DISCOVERY'

161. TS 631.[1] Fig. I, F I.[2]

14. ii. 27. 57° 21′ 20″ S, 46° 43′ 30″ W. Sounding, 3459 m.

Only a few grains of coarse sand yielding single examples of five recognizable genera of Foraminifera, including a specimen of *Hastigerina pelagica*, the only record from the Antarctic material examined.

162. TS 632. Fig. I, F II.

17. ii. 27. Off Signy Island, South Orkneys, 60° 48′ S, 46° 08′ W. Sounding, 320 m.

About 20 cc. dark olive-brown mud which left a residue of less than 1 cc. on 200-mesh silk, composed of mica, diatoms and a few Foraminifera. Only ten species were recorded, *Miliammina arenacea*, *Virgulina schreibersiana* and *Cassidulina crassa* being dominant, the other species, of no particular interest, being very rare.

163. TS 633. Fig. I, F II.

17. ii. 27. Paul Harbour, Signy Island, South Orkneys. Debris from small beam trawl, 18–27 m.

About 30 cc. of algal, zoophyte and crustacean debris, without fine material. Rich in diatoms, it contained very few species of Foraminifera, mostly represented by single specimens, *Haplophragmoides canariensis* alone occurring with any frequency. Among the rarities were *Iridia diaphana* and *Hippocrepina oviformis*.

164. TS 634. Fig. I, F II.

18. ii. 27. East end of Normanna Strait, South Orkneys. Small beam trawl and coarse silk nets attached to trawl, 24–36 m.

The residues from the trawl consisted of a small quantity of crustacean, annelid and sponge debris, with diatoms which formed a felted mass. There were few species of Foraminifera and none of the larger forms. The nets furnished about 40 cc. of fine grey mud. *Cassidulina crassa* and *C. subglobosa* were the only common species. Among the few rarer forms were *Hippocrepinella hirudinea*, *Iridia diaphana* and *Discorbis parisiensis*.

167. TS 635*, 636. Fig. I, F II.

20. ii. 27. Off Signy Island, South Orkneys, 60° 50′ 30″ S, 46° 15′ W. (*a*) Sounding, 344 m.; (*b*) small beam trawl with various nets attached, 244–344 m.

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[1] These are the numbers of the station slides deposited in the Heron-Allen and Earland collection in the Natural History Museum. An asterisk after a number indicates that the particular station slide was mounted by Mr E. Heron-Allen.

[2] These numbers give the reference to the position of the station on either Fig. I or Fig. II, pp. 27–8.

(*a*) The bottom sample consisted of about 20 cc. dark olive-green mud, largely diatomaceous. Foraminifera abundant but in no great variety. Among the rarer forms were *Gordiospira fragilis* and *Hippocrepinella alba*. The dominant species were *Psammosphaera parva*, *Miliammina oblonga*, *M. arenacea*, *Cassidulina crassa*, and ribbons of an organism suggesting *Rhizammina algaeformis*.

(*b*) Organic residues, principally molluscan, angular sand grains and sponge spicules. Foraminifera in the finer material much the same as in (*a*). Some specimens of *Hyperammina subnodosa* selected from the nets were also received.

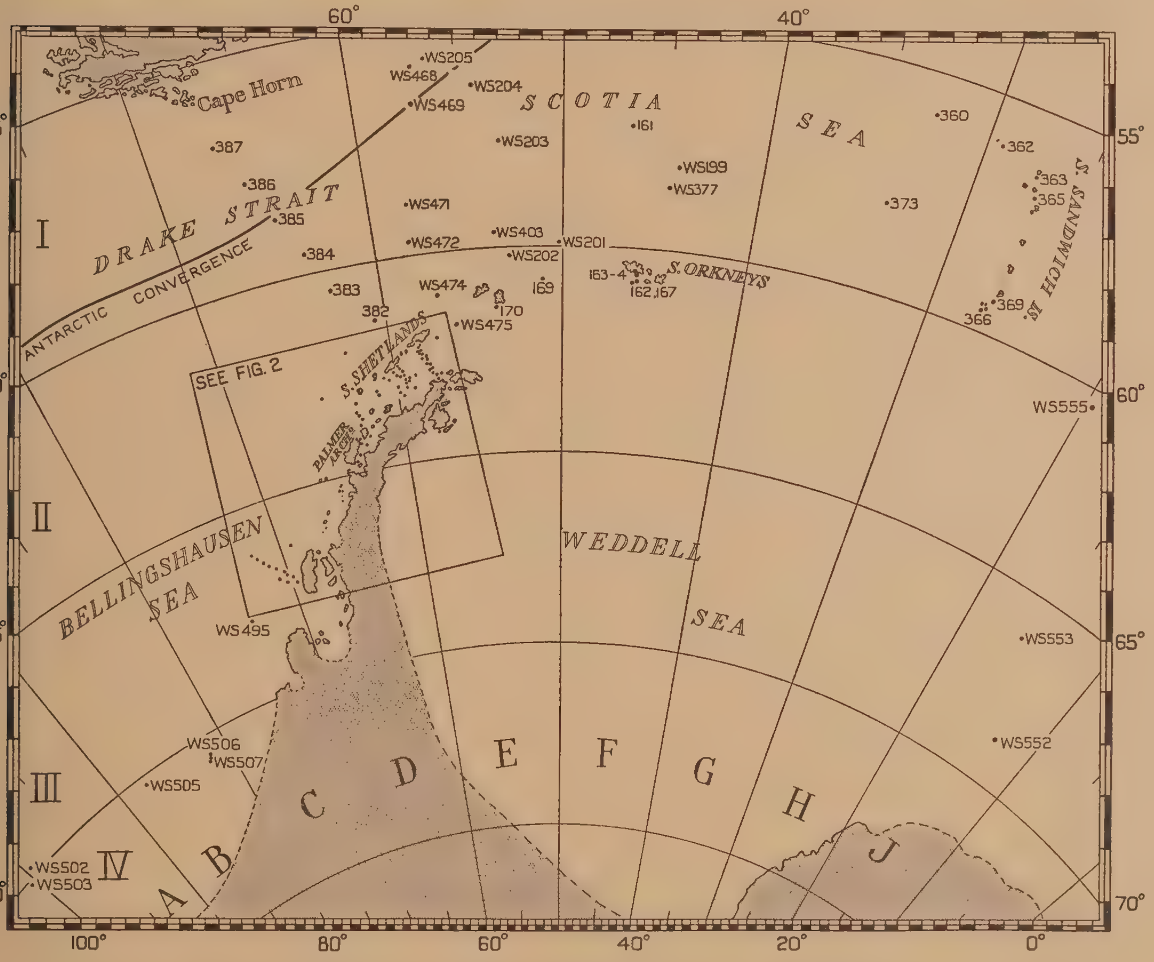

60°
40°
Cape Horn
WS205
WS468
WS204
WS469
SCOTIA
SEA
161
360
362
55°
55°
387
WS203
WS199
WS377
363
365
S. SANDWICH Is.
386
DRAKE STRAIT
385
WS471
373
I
WS403
WS201
WS472
384
WS202
163-4
S. ORKNEYS
ANTARCTIC CONVERGENCE
383
WS474
169
162,167
170
382
WS475
369
366
S. SHETLANDS
SEE FIG. 2
60°
60°
WS555
PALMER ARCH.
II
WEDDELL
SEA
BELLINGSHAUSEN
SEA
WS495
65°
65°
WS553
WS506
WS507
WS552
III
WS505
A
B
C
D
E
F
G
H
J
IV
WS502
WS503
70°
70°
100°
80°
60°
40°
20°
0°

Fig. I. Positions of stations at which Foraminifera were obtained.

169. TS 638. Fig. I, E II.

22. ii. 27. 60° 48′ 50″ S, 51° 00′ 20″ W. Sounding, 2514 m.

About 18 cc. dark grey tenacious mud, a diatom ooze; washed on 200-mesh silk gauze the residue consisted of diatoms (*Coscinodiscus* sp.), Radiolaria, sponge spicules and a few sand grains of varying sizes. Foraminifera few in number and largely pauperate, but with many species of interest including *Proteonina micacea*, *P. tubulata*, *Textularia tenuissima*, *T. nitens*, *T. wiesneri*, *T. antarctica* and *Globotextularia anceps*.

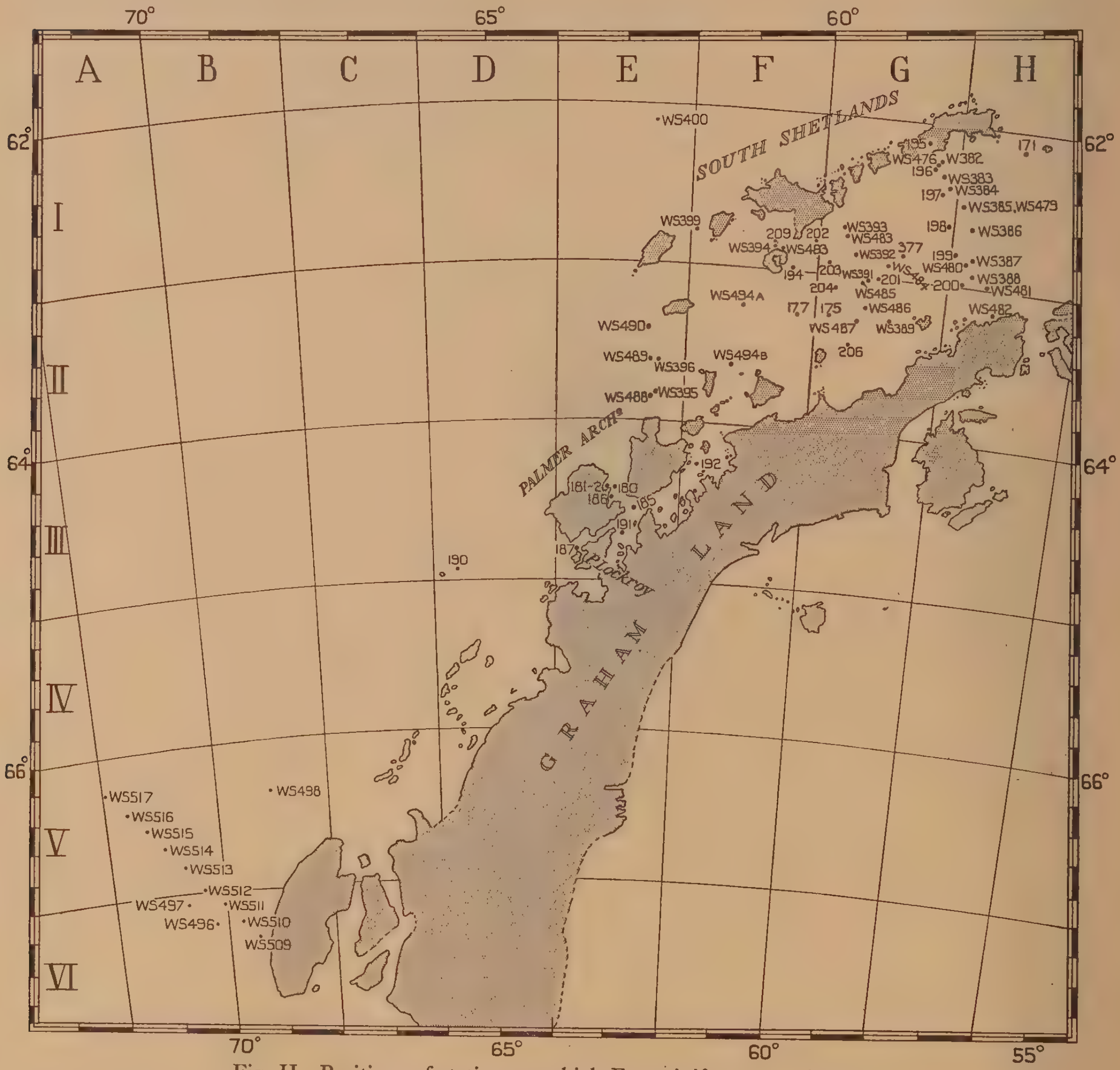
170. TS 641, 642. Fig. I, E II.

23. ii. 27. Off Cape Bowles, Clarence Island, 61° 25′ 30″ S, 53° 46′ W. Dredge, 342 m.

Dark grey sand, of all grades, with stones. This was one of the richest hauls received for variety of Foraminifera, as I understand it was also for other classes of animals. Yet the material did not look promising, as the Foraminifera did not form any appreciable proportion of the bulk.

A tube was received containing some large specimens of *Pilulina jeffreysii* and various species of *Pyrgo*, selected from the material as dredged.

The number of species obtained was astonishing, and they included many forms rarely or never met with at the other stations. Even to make a selection seems impossible, but it may be mentioned that several new species were obtained.


70°
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55°
SOUTH SHETLANDS
PALMER ARCH
GRAHAM LAND
GERLACHE
WS400
WS399
WS394
WS483
WS393
WS392
WS391
WS476
W382
WS383
WS384
WS385, WS479
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WS494A
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Fig. II. Positions of stations at which Foraminifera were obtained.

171. TS 650. Fig. II, H I.

25. ii. 27. 16 miles off Cape Melville, King George Island, South Shetlands. Sounding, 1542 m.

About 15 cc. of brown mud, washed on 200-mesh silk gauze, yielded 2 cc. residue of fine sand and pumice with many diatoms and Foraminifera. *Miliammina arenacea*, *M. oblonga*, *Trochammina bradyi*, *T. inconspicua*, *T. globigeriniformis* and *Textularia tenuissima* were all common. Among rarer forms were *Textularia nitens* and *T. antarctica*.

172. No Station slide. Not marked on map.

26. ii. 27. Off Deception Island, South Shetlands, 62° 59′ S, 60° 28′ W. Dredge, 525 m.

About a pint of coarse scoriae. No organisms found except *Tholosina vesicularis*.

175. TS 686, 687. Fig. II, G II.

2. iii. 27. Bransfield Strait, South Shetlands, 63° 17′ 20″ S, 59° 48′ 15″ W. (*a*) Sounding; (*b*) dredge, 200 m.

The sounding (*a*) consisted of a small quantity of muddy sand which gave 2 cc. residue of dark angular sand grains of varying sizes. Few organisms except scanty and pauperate Foraminifera of the usual local species, *Turritellella laevigata* being the only one of particular interest. From the dredge was received (i) a tube with picked out specimens of *Pilulina jeffreysii*, *Planispirina bucculenta* and some large *Pyrgo*; (ii) a box of stones with a few sessile Foraminifera of the common species; (iii) a quantity of very dark sand with few apparent organisms. The coarser siftings yielded very few Foraminifera except *Reophax* spp. and *Pyrgo* spp. The finer material was floated with carbon tetrachloride and the floatings yielded a very long list of species. The customary fauna was well represented, and by numerous specimens. There were also a great number of unusual species including *Patellina corrugata*, *Hormosina ovicula*, *Thurammina spumosa*, *T. albicans*, *T. corrugata*, *T. papillata*, *T. compressa*, *T. haeusleri*, *Hyperammina clavigera*, *Psammophax consociata*, *Ammodiscoides turbinatus*, *Technitella bradyi* and many species of *Lagena*.

177. TS 697, 698. Fig. II, F II.

5. iii. 27. 27 miles south-west of Deception Island, South Shetlands. Dredge, 1080 m.

The material received included (i) a tube with some specimens selected from the dredge—*Crithionina pisum*, *Pelosina fusiformis*, *Jaculella obtusa*, *Rhabdammina discreta* and *Reophax nodulosus*; (ii) a box of stones of all sizes, many of which had sessile Foraminifera including *Webbinella depressa*, *Dendronina papillata* and *Sorosphaera depressa*; (iii) a quantity of coarse black volcanic sand with few organic remains except a few Arenacea; and (iv) about 70 cc. of fine black sand, chiefly scoriae.

Nos. (iii) and (iv) after washing to remove mud were floated with carbon tetrachloride which was only a partial success, as a good deal of pumice floated with the Foraminifera. About 2 cc. of floatings were obtained, so it is clear that Foraminifera formed an infinitesimal proportion of the bulk, certainly less than 0·01 per cent. A very large number of species were picked out from the floatings, but with the exception of about twenty of the commoner forms, rarely more than two or three specimens of each species. Among the rarer forms listed were *Astrorhiza polygona*, *Ophthalmidium margaritiferum*, *Trochammina globulosa*, several species of *Thurammina*, *Hyperammina clavigera*, *Bathysiphon argillaceus*, *Proteonina tubulata*, *Ehrenbergina pupa*, *Elphidium incertum* and *Hippocrepinella alba*.

180. TS 707*, 708*. Fig. II, E III.

11. iii. 27. 1·7 miles west of north point of Gand Island, Schollaert Channel, Palmer Archipelago. (*a*) Sounding, (*b*) dredge, 160 m.

The sounding (*a*) contained about 14 cc. of brown mud with a residue of angular sand grains, diatoms, sponge spicules and scanty Foraminifera of the usual local species, none of particular interest. From the dredge was received a jar of coarse dark sand and mud. Foraminifera formed a very small percentage of the material, and were mainly Arenacea, some of which were very abundant, notably *Proteonina difflugiformis*, *Psammosphaera fusca*, *Pelosina variabilis*, *Reophax scorpiurus*, *R. pilulifer*, *R. dentaliniformis*. Other very common species were *Globigerina pachyderma*, *Virgulina bradyi* and *Miliolina seminulum*. A long list of rarer forms.

181. TS 709. Fig. II, E III.

12. iii. 27. Schollaert Channel, Palmer Archipelago, 64° 20′ S, 63° 01′ W. Nets on trawl, 160–335 m.

Two samples received. (i) Muddy sand with about 50 per cent organic debris, principally echinoderm. *Pelosina*, generally fragmentary, formed a considerable proportion of the coarse residue, other Foraminifera were not numerous. (ii) A quantity of muddy sand without coarse debris. Many Foraminifera obtained by elutriation and a long list of species. *Reophax* and *Haplophragmoides* of several species, *Recurvoides contortus*, *Proteonina difflugiformis*, *Pelosina variabilis* and *Trochammina bradyi* were all very common. Among rarer forms were *Dendronina arborescens* var. *antarctica*, *Astrorhiza triangularis*, *Pelosina arborescens*, *Thurammina spumosa* and *T. corrugata*.

182. TS 710*, 711*, 711 A. Fig. II, E III.

14. iii. 27. Schollaert Channel, Palmer Archipelago, 64° 21′ S, 62° 58′ W. Nets on trawl, 278–500 m.

A small jar of coarse sand and flocculent organic debris. No mud or fine material. Residue coarse angular sand with abundant *Reophax pilulifer* and other large species of Foraminifera. Among the rarer species were *Armorella sphaerica*, *Thurammina spumosa*, *Astrorhiza triangularis* and *Sorosphaera depressa*. Very few of the smaller species were listed.

185. TS 714*. Fig. II, E III.

16. iii. 27. De Gerlache Strait, Palmer Archipelago. Sounding, 598 m.

About 8 cc. tenacious grey mud gave less than 1 cc. residue of sand grains of all sizes, diatoms, sponge spicules and eight species of Foraminifera, all represented by single specimens, except *Miliammina oblonga*, which was evidently dominant in the deposit.

186. TS 712*, 713. Fig. II, E III.

16. iii. 27. Fournier Bay, Anvers Island, Palmer Archipelago. Dredge, 295 m.

About 30 cc. coarse muddy sand with a residue of angular sand grains of all sizes, a few diatoms and Foraminifera. *Reophax dentaliniformis* was very common; *Miliammina oblonga* and *M. lata* common; about thirty other common species varying from frequent to very rare. Nothing very notable except *Armorella sphaerica* and *Ehrenbergina parva*.

187. TS 717, 718*. Fig. II, E III.

18. iii. 27. Neumayr Channel, Palmer Archipelago. Sounding, 200 m., 259 m.

Two samples were received.

(i) About 10 cc. brown mud from 200 m. yielding 1 cc. residue of angular sand grains of all sizes and large diatoms (*Triceratium*). Foraminifera inconspicuous, mostly dead shells. *Miliammina* of various species, *Virgulina bradyi* and *V. schreibersiana* were the only forms occurring with any frequency.

(ii) About 5 cc. dark grey mud from 259 m., with a residue of angular sand grains and diatoms yielded seven species of common Foraminifera, represented in all cases but one by a single specimen.

190. TS 721. Fig. II, D III.

24. iii. 27. Bismarck Strait, Palmer Archipelago. Large rectangular net, 93–130 m.

A small quantity of sponge and polyzoan debris with many diatoms. No Foraminifera in the coarse material; a long list of species was obtained from the finer grades, but with few exceptions specimens of each were not numerous. The common species were *Saccorhiza ramosa*, *Tolypammina vagans*, *Haplophragmoides canariensis*, *Trochammina nana*, *T. ochracea*, *Discorbis vilardeboanus*, *Cibicides lobatulus* and *C. refulgens*. Among rarer forms of interest were *Armorella sphaerica*, *Turritellella shoneana*, *Hippocrepina flexibilis* and *Spirillina tuberculata*.

191. TS 715*. Fig. II, E III.

25. iii. 27. De Gerlache Strait, Palmer Archipelago. Sounding, 310 m.

About 15 cc. grey mud, with a residue of sand grains, diatoms, sponge spicules and very rarely Foraminifera. No species except *Trochammina inconspicua* occurred with any frequency. A single specimen of *Lagena striata* and one of *Spiroplectammina biformis* were the only outstanding records.

192. TS 700. Fig. II, F III.

27. iii. 27. Off C. Kaiser, Brabant Island, Palmer Archipelago. Sounding, 800 m.

About 15 cc. tenacious dark grey mud yielded less than 0·5 cc. residue on silk gauze, largely sand grains and diatoms. Foraminifera few but varied, and generally pauperate, the arenaceous forms being extremely fragile. *Bolivina punctata* common, several species of *Trochammina* and *Miliammina oblonga* frequent. Among rarer forms were *Reophax flexibilis* and *Textularia antarctica*.

194. TS 695. Fig. II, F I.

28. iii. 27. 2½ miles east of Deception Island, South Shetlands. Sounding, 812 m.

About 10 cc. dark mud giving a residue of dark volcanic sand. Foraminifera few in numbers but varied, including, in addition to all the common local forms, many rarities among which were *Vanhoeffenella oculus* and *Reophax micaceus*.

195. TS 664*. Fig. II, G I.

30. iii. 27. Admiralty Bay, King George Island, South Shetlands. Dredge, 391 m.

A small quantity of tenacious dark mud, with a residue of angular sand grains. Foraminifera scanty but rather varied. *Cassidulina crassa*, *C. subglobosa*, *Virgulina schreibersiana* and *V. bradyi* were the only common species. Among the rarer forms were *Textularia antarctica*, *Ehrenbergina parva* and *Lagena reniformis*.

196. TS 667, 668, 669. Fig. II, G I.

3. iv. 27. Bransfield Strait, South Shetlands, 62° 17′ 30″ S, 58° 21′ W. (*a*) Sounding, 720 and 1011 m.; (*b*) muddy residue from townet, 720 m.

Two separate soundings (*a*) were received from 720 and 1011 m. respectively, each a dark brown mud yielding residues of fine dark sand, diatoms, sponge spicules and scanty Foraminifera. *Trochammina bradyi*, *Miliammina arenacea*, *Textularia tenuissima* and *Bolivina punctata* were common; the other species varied but presenting no unusual forms. The muddy residues (*b*), from a townet which had touched bottom, differed in having few of the small species found in the soundings, these having been washed away. *Reophax dentaliniformis*, *Haplophragmoides canariensis* and *Recurvoides contortus* were common. A new *Astrorhiza*, *A. polygona*, was very rare.

197. TS 672. Fig. II, G I.

3. iv. 27. Bransfield Strait, South Shetlands, 62° 27′ S, 58° 11′ 30″ W. Sounding, 1974 m.

About 12 cc. brown mud leaving hardly any residue: very few mud pellets, diatoms and Foraminifera which were nearly all pauperate. *Trochammina bradyi* was the only common species. *Recurvoides contortus*, *Textularia tenuissima* and *Miliammina obliqua* were frequent. Most other species represented by one or two specimens, and none was of particular interest.

198. TS 673. Fig. II, G I.

3. iv. 27. Bransfield Strait, South Shetlands, 62° 38′ S, 58° 04′ W. Sounding, 1600 m.

About 10 cc. dark brown mud yielded a residue of less than 1 cc. mud pellets, sand grains, diatoms and a few Foraminifera. *Miliammina* spp. and *Trochammina bradyi* were as usual the commonest forms, most others being rare or very rare. Among them were *Vanhoeffenella oculus*, *Textularia tenuissima*, *Proteonina tubulata*, *Ehrenbergina pupa*, and *Reophax longiscatiformis*.

199. TS 655. Fig. II, H I.

4. iv. 27. Bransfield Strait, South Shetlands, 62° 49′ S, 57° 56′ 30″ W. Sounding, 735 m.

A few cc. of dark mud yielding 1 cc. residue of dark sand, some sponge spicules and diatoms. Foraminifera represented by a few species only and, except for *Miliammina arenacea* and *M. oblonga* which were common, by one or two specimens only of each species, none being of particular interest.

200. TS 659. Fig. II, H I.

4. iv. 27. Bransfield Strait, South Shetlands, 62° 59′ 30″ S, 57° 49′ W. Sounding, 345 m.

About 8 cc. dark brown mud yielded 3 cc. residue of dark angular sand with many diatoms and a considerable number of species of Foraminifera, mostly represented by one or two specimens. The only species occurring with any frequency were *Miliammina arenacea*, *M. oblonga*, *Trochammina ochracea* and *Uvigerina angulosa*. Ten species of *Lagena* were recorded.

201. TS 679. Fig. II, G I.

5. iv. 27. Bransfield Strait, South Shetlands, 63° 30″ S, 59° 06′ 30″ W. Sounding, 343 m.

The tube broke and most of the sounding was lost. About 4 cc. dark mud which was left yielded a residue of dark sand, many diatoms and Foraminifera. With the exception of *Cassidulina crassa*, which was common, and *Globigerina* (three species) frequent, the remaining species were represented by a few specimens only, none being of outstanding interest.

202. TS 689. Fig. II, F I.

5. iv. 27. Bransfield Strait, South Shetlands, 62° 48′ S, 60° 05′ W. Sounding, 909 m.

About 15 cc. dark brown mud left a residue of 3 cc. black volcanic sand with few organic remains. There were a fair number of species of Foraminifera, but with the exception of *Miliammina arenacea* and *Bolivina punctata*, not more than single or few specimens of each, and nothing of outstanding importance.

203. TS 678. Fig. II, G I.

5. iv. 27. Bransfield Strait, South Shetlands, 62° 56′ S, 59° 50′ W. Sounding, 949 m.

About 15 cc. tenacious dark brown mud which left a residue of 2 cc. black volcanic sand. Foraminifera few in numbers and pauperate, but varied in species. *Psammosphaera fusca*, *Reophax scorpiurus*, *Recurvoides contortus*, *Miliammina arenacea*, *M. obliqua*, *Bolivina punctata*, *Virgulina bradyi*, *Globigerina pachyderma*, *Nonion depressulus* and *Nonionella iridea* were the only species represented in any numbers. *Ehrenbergina parva* was the only noteworthy rarity.

204. TS 682. Fig. II, G II.

6. iv. 27. Bransfield Strait, South Shetlands, 63° 05′ S, 59° 42′ W. Sounding, 943 m.

About 12 cc. dark brown mud gave a residue of black volcanic sand with few organisms of any kind. Foraminifera very rare except *Miliammina oblonga*, *Trochammina malovensis*, *T. nana*, *Virgulina bradyi* and *Textularia tenuissima*. Nothing outstanding among the other species recorded.

206. TS 688. Fig. II, G II.

6. iv. 27. Bransfield Strait, South Shetlands, 63° 26′ S, 59° 28′ W. Sounding, 310 m.

About 15 cc. dark brown mud left 3 cc. residue of grey sand with many diatoms and few Foraminifera. *Miliammina arenacea*, *Trochammina ochracea* and *T. rotaliformis* were the only species occurring with any frequency. Among the rarer forms were *Thurammina haeusleri* and a fragment of *Psammatodendron indivisum*.

209. TS 693. Fig. II, F I.

14. iv. 27. Port Foster, Deception Island, South Shetlands. Sounding, 168 m.

About 25 cc. brown mud yielded as residue a large water-worn lump of pumice, some mud lumps and many Foraminifera of few species. *Miliammina oblonga*, *M. obliqua* and *Trochammina malovensis* were common, *Reophax dentaliniformis* and *R. fusiformis* frequent. Among rarer species were *Textularia nitens*, *Spiroplectammina biformis* and *Ehrenbergina parva*.

360. TS 629 C. Fig. I, G I.

24. ii. 30. 55° 53′ S, 32° 33′ W to 55° 50′ S, 32° 26′ 30″ W. Sounding, 3264 m.

A small quantity of ooze, diatoms, Radiolaria and fine rounded sand grains in about equal proportions. Foraminifera very rare, all small species or pauperate forms of larger species, but furnishing a varied list. None of the species was other than rare and many were represented by one or two specimens. Among them were several interesting forms, *Gaudryina ferruginea*, *Nodellum membranaceum*, *Reophax communis*, *Spirolocammina tenuis*, *Trochammina vesicularis*, *Spiroplectammina subcylindrica*, *S. typica*, *S. filiformis*, *Spiroplectella cylindroides* and *Gaudryina minuta*.

362. TS 629 A. Fig. I, H I.

25. ii. 30. 56° 04′ S, 29° 15′ W to 56° 03′ 15″ S, 29° 20′ W. Sounding, 3370 m.

A very small quantity of pale grey diatom ooze, nearly all passing through 200-mesh silk sieve, leaving a few large Foraminifera and scanty small species, entangled with diatoms. *Proteonina difflugiformis* and *Verneuilina bradyi* were the only species present in any numbers. A fair number of the usual deep-water species of Arenacea were recorded and among rarer forms *Ammobaculites foliaceus* var. *recurva*, *Bigenerina minutissima* and *Spiroplectammina filiformis*.

363. TS 627 D. Fig. I, H I.

26. ii. 30. 2·5 miles S 80° E of south-east point of Zavodovski Island, South Sandwich Islands. Dredge, 329–278 m.

About a cupful of dark mud, volcanic ash and scoriae. Foraminifera scanty but varied, and with some interesting species including *Ophthalmidium inconstans*, *Proteonina tubulata*, *Botellina goësii*, *Reophax cushmani*, *Ammosphaeroidina sphaeroidiniformis*, *Trochammina vesicularis*, *Turritellella laevigata*, *Verneuilina superba* and *Lagena squamoso-alata*.

365. TS 627 E. Fig. I, H I.

2. iii. 30. Between Visokoi and Candlemas Islands, South Sandwich Islands. Sounding, 1536 m.

A small quantity of grey mud, with a residue of diatoms and black volcanic ash. Foraminifera extremely rare. The only species occurring with any frequency were *Textularia tenuissima* and *T. wiesneri*. Among the rarer forms were *Vanhoeffenella oculus*, *Hormosina ovicula* and *H. globulifera*.

366. TS 628. Fig. I, H I.

6. iii. 30. 4 cables south of Cook Island, South Sandwich Islands. Dredge, 155–322 m.

About a cupful of black volcanic mud, elutriations principally pumice and worm tubes built of pumice. Foraminifera very scanty, the only species occurring in any numbers being *Haplophragmoides canariensis*, *Trochammina malovensis* and four species of *Miliammina*, *arenacea*, *circularis*, *lata* and *obliqua*. Among the rarer species were *Storthosphaera elongata* and *Pilulina arenacea*.

367. No station slide. Not marked on map.

7. iii. 30. Beach Point, Thule Island, South Sandwich Islands. Sand from beach (surf line).

About a cupful of black volcanic sand yielded no organic remains of any kind.

369. TS 628 A. Fig. I, H I.

9. iii. 30. Between Southern Thule and Bristol Islands, South Sandwich Islands. Sounding, 1767 m.

A small quantity of brown mud with a residue of scoriae of all sizes up to that of a pea, diatoms and volcanic ash. Foraminifera were rare but varied, the only common species being *Globigerina pachyderma*. *Textularia tenuissima*, *Virgulina bradyi* and *Bulimina aculeata* were frequent, all other species rare, and often represented by single specimens. A few good specimens of *Hormosina globulifera* and *Cyclammina orbicularis* and a single *Spiroplectammina typica* were recorded.

373. TS 629 B. Fig. I, G I.

19. iii. 30. 58° S, 33° 44′ W. Sounding, 2515 m.

A small quantity of tenacious glacial mud with pebbles and sand grains of all sizes. Foraminifera very scanty in the coarse material and hardly any in the fine. Radiolaria and diatoms abundant; but this was not a diatom ooze as stated in the Station List, the sand and Radiolaria being estimated at 45 per cent of the bulk as against 10 per cent diatoms. *Psammosphaera fusca* was the only species occurring in any numbers, all the others being rare and generally represented by one or two specimens. The species were all arenaceous and of the usual deep-water Antarctic forms, the only notable specimens being *Thurammina albicans* and *Bigenerina minutissima*.

377. TS 662 A. Fig. II, G I.

12. iv. 30. 62° 52′ S, 58° 43′ W. Sounding, 768 m.

A small quantity of dark brown mud, with a residue of pebbles and sand grains of all sizes, mostly volcanic, and diatoms. Very few Foraminifera, the only species occurring with any frequency being *Miliammina arenacea*, *M. obliqua*, and *Haplophragmoides canariensis*. On the pebbles were *Sorosphaera depressa*, *Tolypammina vagans* and *Tholosina vesicularis*. Nothing very noteworthy among the remaining species, which were represented by single or few specimens.

382. TS 690 A. Fig. I, D II.

13. iv. 30. 61° 27′ 30″ S, 61° 38′ 30″ W. Sounding, 3647 m.

The sounding was a cylinder of tenacious light brown clay, a true red clay, showing distinct layers of stratification. Except the harder flakes which were retained on a 30-mesh sieve, nearly all passed through a 200-mesh silk sieve. The residue contained flakes of refractory clay, a few large sand grains, and many Radiolaria, but very few Foraminifera, nearly all arenaceous. *Haplophragmoides subglobosus*, *Ammomarginulina ensis* and *Clavulina communis* were frequent, all other species very rare. *Spirolocammina tenuis*, *Cyclammina orbicularis* and *Spiroplectammina subcylindrica* were among the rarer species recorded.

383. TS 701 A. Fig. I, D II.

14. iv. 30. 60° 32′ S, 62° 42′ W. Sounding, 3744 m.

About 70 cc. tenacious light brown mud giving a residue of small angular pebbles, angular sand grains of all sizes, pellets of clay and many Radiolaria. Foraminifera scanty, none present in any numbers but a great many species represented by single or few specimens, many of them dead shells. *Tolypammina vagans* and *Saccorhiza ramosa* were frequent on the pebbles. *Psammosphaera fusca*, *Haplophragmoides subglobosus*, *Uvigerina asperula* and *Globigerina pachyderma* the only common species. Among the rarer species were *Cassidulina pacifica*, *C. elegans*, *Ehrenbergina hystrix* and *Spiroplectammina filiformis*.

384. TS 719 B, 719 C. Fig. I, D I.

14. iv. 30. 59° 36′ 30″ S, 63° 43′ 30″ W. Sounding, 3663 m.

About 20 cc. brown mud with visible *Globigerinae*. Residue a few manganese-coated pebbles or nodules, *Globigerina* ooze and fine sand. Very few Radiolaria. The nodules were encrusted with *Tolypammina vagans*, and some colonies of *Placopsilina confusa* and *Placopsilinella aurantiaca*. The ooze was largely made up of *Globigerina pachyderma*, which was dominant, *G. dutertrei* very abundant, with four other species of *Globigerina* in lesser numbers. *Lagena* was represented by over forty species and varieties, several being new, but the number of each very small, often single specimens. A very long list of other species, many being of great interest.

385. TS 719 D. Fig. I, D I.

15. iv. 30. 58° 41′ S, 64° 43′ 30″ W. Sounding, 3638 m.

About 70 cc. tenacious biscuit-coloured ooze with a residue of a manganese nodule, several pebbles and large sand grains, some coated with manganese, *Globigerinae*, Radiolaria and very fine angular sand. *Globigerina pachyderma* dominant. *G. inflata*, *G. dutertrei*, *G. conglomerata*, *G. triloba* and *G. bulloides* in this order of decreasing abundance. A long and varied list of other species including many forms of great interest. *Lagenae* were very varied, over sixty species and varieties, but the majority of them very rare.

386. TS 719 E. Fig. I, D I.

15. iv. 30. 57° 45′ 30″ S, 65° 42′ W. Sounding, 4773 m.

About 75 cc. biscuit-coloured tenacious mud gave a residue of *Globigerina* ooze with a large percentage of fine angular sand and many Radiolaria. Probably 98 per cent of the Foraminifera consisted of *Globigerina pachyderma* and *G. inflata*, which were dominant, in association with *G. dutertrei*, *G. bulloides*, *G. conglomerata* (in order of lessening abundance) and *Globorotalia truncatulinoides*. A long list of other species, many of great interest, but represented in most cases by very few specimens. *Lagenae* represented again by a great number of species and varieties, but often only a single specimen of each.

387. TS 719 F. Fig. I, D I.

16. iv. 30. 56° 50′ S, 66° 39′ W. Sounding, 3102 m.

A few cc. of grey ooze, residue 1 cc. of *Globigerinae* and fine angular sand. *Globigerina conglomerata*, *G. pachyderma*, and *G. inflata* very common; *G. dutertrei*, *Globorotalia truncatulinoides* and *G. scitula* common; the nineteen other species recorded being rare or very rare. Only three species of *Lagena* were listed, and the only species of outstanding interest were *Bolivina decussata* and *Ehrenbergina pupa*, one specimen of each.

No Station no. TS 694. Fig. II, F I.

26. ii. 27. South Shetlands, 62° 57′ S, 60° 20′ 30′ W. Sounding, 967 m.

About 15 cc. of tenacious slate-coloured mud gave a residue of 2 cc. of black scoriae, sand, many diatoms and a few Foraminifera. *Miliammina arenacea* and *M. obliqua* frequent, also several species of *Trochammina*. *Bolivina punctata* was common and both megalospheric and microspheric forms were recorded. Among rarer species were *Textularia nitens* and *T. antarctica*.

No Station no. TS 720*. Fig. II, D III.

19. iii. 27. Palmer Archipelago, 64° 56′ S, 64° 43′ W. Sounding, 435 m.

About 13 cc. of pale brown mud, yielding a residue of angular sand grains of all sizes, and diatoms. Foraminifera in poor condition and very few in numbers, *Miliammina* spp. and *Bulimina patagonica* only occurring with any frequency. Nothing of particular interest except a fine specimen of *Reophax guttifer* with six chambers.

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WS 199. TS 629. Fig. I, F I.

20. iv. 28. 58° 10′ S, 44° 10′ W. Sounding, 3813 m.

About 35 cc. of slate-grey mud, easily washed but leaving little residue; angular white sand, diatoms, Radiolaria and Foraminifera. These latter, though few in number and mainly arenaceous, yielded a varied list of species including *Proteonina tubulata*, *Thurammina albicans*, *Textularia tenuissima*, *Reophax micaceus*, *Ammomarginulina ensis*, *Bigenerina minutissima* and *Spirolocammina tenuis*.

WS 201. TS 637. Fig. I, E I.

22. iv. 28. 59° 57′ S, 50° 12′ W. Sounding, 4134 m.

About 20 cc. of light brown muddy sand, which yielded a residue of small pebbles and grey sand with many Arenacea. *Saccammina sphaerica*, *Haplophragmoides subglobosus*, *Recurvoides contortus* and *Clavulina communis* were all more or less common. Among the rarer species were *Ammosphaeroidina sphaeroidiniformis*, *Reophax cushmani*, *Textularia wiesneri*, and *Ammobaculites foliaceus*

WS 202. TS 640. Fig. I, E II.

23. iv. 28. 60° 23′ S, 52° 52′ W. Sounding, 3987 m.

A few cc. of dark grey mud with included harder lumps. The material was refractory, the lumps failing to disintegrate after repeated drying and washing. They appeared to consist of sand mixed with diatoms and were riddled with labyrinthic tunnels of some unknown organism. No Foraminifera seen in the lumps, but the finer residues yielded single specimens of six species of Foraminifera, some Radiolaria and many diatoms.

WS 203. TS 639. Fig. I, E I.

25. iv. 28. 57° 42′ S, 53° 12′ W. Sounding, 4259 m.

A few cc. of pale brown mud. Washed on 200-mesh silk gauze it gave a residue of Radiolaria, diatoms, and sand with many Foraminifera, generally rather pauperate. *Globigerina pachyderma*, *Psammosphaera fusca*, *Trochammina bradyi*, *T. squamata*, *T. nana* were all frequent. Among the rarer species were *Reophax longiscatiformis*, *Gaudryina apicularis*, *Ammomarginulina ensis* and *Spiroplectammina filiformis*.

WS 204. TS 643. Fig. I, E I.
26. iv. 28. 56° 27′ S, 54° 22′ W. Sounding, 3388 m.

A few cc. of pale brown mud yielding a residue of *Globigerina* ooze with some sand grains and many Radiolaria. *Globigerina inflata* was dominant, *G. conglomerata*, *G. pachyderma*, *G. elevata*, *G. bulloides*, *G. dutertrei* and *G. triloba* coming next in this order of frequency. A new species of *Globigerina*, *G. megastoma*, was represented by a few specimens. The finer material yielded a long list of species, including many *Lagenae* and some interesting rarities.

WS 205. TS 645 A. Fig. I, E I.
27. iv. 28. 55° 49′ S, 56° 18′ W. Sounding, 4207 m.

A few cc. of pale brown mud yielding a residue of *Globigerinae* and *Globorotaliae*, with a little angular sand. *Globigerina inflata* and *G. pachyderma* were dominant. Other Foraminifera were generally represented by a few specimens only, and few were of outstanding interest.

WS 377. TS 630. Fig. I, F I.
9. ii. 29. 58° 34′ S, 44° 47′ W. Sounding, 2552 m.

About 20 cc. light brown-grey ooze which yielded a residue of 3 cc. on 200-mesh silk gauze. The residue was principally sand with a few tiny pebbles, Radiolaria and diatoms. Foraminifera were very rare and mostly small and pauperate. The only species occurring with any frequency was *Textularia tenuissima*, most of the other species being represented by single specimens.

WS 381. No Station slide. Not marked on map.
14. ii. 29. 61° 26′ S, 56° 19′ W. Sounding, 425 m.

A pinch of muddy sand with a few sponge spicules and diatoms contained no Foraminifera.

WS 382. TS 665*. Fig. II, G I.
15. ii. 29. 62° 15′ 35″ S, 58° 18′ 30″ W. Sounding, 425 m.

About 30 cc. dark brown mud yielded very few Foraminifera, *Miliammina arenacea* being the only common species. *Psammosphaera fusca*, *Virgulina bradyi* and *Cassidulinoides parkerianus* occurred frequently; all other species very rare, and none of particular interest.

WS 383. TS 670*. Fig. II, G I.
15. ii. 29. 62° 20′ 40″ S, 58° 13′ W. Sounding, 2085 m.

About 40 cc. dark slate-coloured mud yielded 2 cc. residue of fine sand, diatoms and sponge spicules with many Foraminifera, though of limited species. *Psammosphaera parva*, *Recurvoides contortus*, *Trochammina inconspicua*, *T. bradyi*, *T. malovensis*, and *Cassidulina crassa* were all more or less common. Among the rarities were *Proteonina tubulata* and *Textularia antarctica*.

WS 384. TS 671*. Fig. II, G I.
15. ii. 29. 62° 25′ 40″ S, 58° 06′ 10″ W. Sounding, 1957 m.

About 40 cc. brown mud left hardly any residue on 200-mesh silk gauze. Foraminifera were plentiful though limited in species. *Miliammina oblonga* and *Trochammina bradyi* were very common. Among rare forms were *Cyclammina orbicularis*, *Proteonina tubulata* and *Hippocrepinella alba*.

WS 385. TS 652. Fig. II, H I.
16. ii. 29. 62° 32′ S, 57° 55′ W. Sounding, 1838 m.

About 50 cc. dark brown mud, nearly all of which passed through 200-mesh silk gauze, leaving a residue of mud flakes, volcanic ash and diatoms. Foraminifera very rare except *Miliammina* spp., *Trochammina bradyi* and *T. malovensis*, but including many interesting species such as *Vanhoeffenella oculus*, *Hippocrepinella alba* and *Thurammina papillata*.

WS 386. TS 653*. Fig. II, H I.

16. ii. 29. 62° 41′ S, 57° 44′ W. Sounding, 1392 m.

About 35 cc. dark brown mud yielding a residue of 3 cc. fine dark sand, diatoms, sponge spicules and many Foraminifera. *Recurvoides contortus*, *Trochammina bradyi* and several species of *Miliammina* were common, while rarer forms included *Proteonina tubulata*, *Textularia nitens* and *T. wiesneri*.

WS 387. TS 654. Fig. II, H I.

16. ii. 29. 62° 49′ S, 57° 40′ W. Sounding, 640 m.

About 40 cc. dark brown mud yielding a residue of nearly black volcanic sand, with a small proportion of larger fragments. Foraminifera very scanty, except various species of *Miliammina* which were more or less common. No species of outstanding interest were observed.

WS 388. TS 657*. Fig. II, H I.

16. ii. 29. 62° 55′ 30″ S, 57° 40′ W. Sounding, 446 m.

A few cc. pale brown mud yielded a residue of mud flakes, sand grains, diatoms and vegetable fibres. A single specimen each of *Hormosina ovicula* and *Cibicides refulgens* represented the Foraminifera of the sample.

WS 389. TS 684*. Fig. II, G II.

16. ii. 29. 63° 17′ S, 58° 51′ 05″ W. Sounding, 130 m.

A few cc. dark brown mud. Residue on 200-mesh silk consisted of dark sand grains, sponge spicules, diatoms and a few Foraminifera. The only species occurring with any frequency were *Psammosphaera fusca*, *Trochammina malovensis* and *Miliammina arenacea*. Nothing outstanding among the rarer species.

WS 391. TS 680*. Fig. II, G II.

17. ii. 29. 63° 02′ S, 59° 12′ W. Sounding, 877 m.

About 30 cc. dark brown mud, leaving a residue of black volcanic sand with very few organic remains. *Miliammina* spp., *Trochammina nana* and *Virgulina bradyi* were frequent; most other species represented by a few specimens, none of particular interest.

WS 392. TS 676. Fig. II, G I.

17. ii. 29. 62° 52′ S, 59° 26′ W. Sounding, 591 m.

Only a pinch of dark sand was received, which contained many specimens of *Globigerina pachyderma* and *G. dutertrei*, a few *G. conglomerata* and single specimens of six other common species.

WS 393. TS 674*. Fig. II, G I.

17–18. ii. 29. 62° 42′ S, 59° 41′ W. Sounding, 900–1138 m.

Three soundings were received from 900–1000, 1051 and 1138 m. respectively. They were all the same, a dark brown mud yielding small residues of black sand, with diatoms and very few Foraminifera. Nothing occurred with any frequency, and nearly all were of the usual Antarctic species, found in most gatherings. Among the rarer forms were *Vanhoeffenella gaussi* and *Ehrenbergina parva*.

WS 394. TS 692*. Fig. II, F I.

18. ii. 29. 62° 51′ S, 60° 40′ W. Sounding, 274 m.

About 40 cc. dark brown mud, leaving a residue of black volcanic sand with very few organic remains. Foraminifera represented by one or two specimens each of the commoner local species, only *Reophax pilulifer*, *Miliammina arenacea* and *M. oblonga* occurring with greater frequency.

WS 395. TS 705*. Fig. II, E II.

19. ii. 29. 63° 48′ 30″ S, 62° 26′ W. Sounding, 297 m.

About 40 cc. dark brown mud left only 2 cc. residue on fine silk, consisting of fine sand, diatoms, sponge spicules and many Foraminifera of the local species, some being very common. There was a varied list of other forms, but few of special interest except *Ehrenbergina parva*.

WS 396. TS 704*. Fig. II, E II.

19. ii. 29. 63° 38′ 30″ S, 62° 28′ 30″ W. Sounding, 318 m.

A few cc. brown mud, with a residue of fine sand, a few diatoms and occasional Foraminifera. Ten species in all were recorded, a few specimens of each, the only species occurring with greater frequency being *Virgulina bradyi*. None of the others was of particular interest.

WS 399. TS 690*. Fig. II, F I.

20. ii. 29. 62° 50′ S, 61° 58′ 30″ W. Sounding, 738 m.

A few cc. light brown mud yielding a residue of dark sand with few organic remains. Only nine species of Foraminifera were listed, each represented by one or two specimens, the only rarity being a single specimen of *Lagena revertens*.

WS 400. TS 701. Fig. II, E I.

21. ii. 29. 62° 07′ S, 62° 33′ W. Sounding, 4517 m.

About 35 cc. of tenacious brown mud, (a red clay), which resisted the usual cleaning processes and was eventually broken down with hot soda solution. It left a residue of 1 cc. sand grains of all sizes, many being large, a few Radiolaria, diatoms and Foraminifera. The latter were very rare but varied. In addition to many normal deep-water species were several rarer forms, including *Proteonina tubulata*, *Spiroplectammina subcylindrica*, *Ammomarginulina ensis*, *Spirolocammina tenuis* and *Cystammina argentea*.

WS 403. TS 719 A. Fig. I, E I.

22. ii. 29. 59° 40′ S, 64° 35′ W. Sounding, 3721 m.

About 60 cc. pale brown mud yielded about 12 cc. residue, at least 60 per cent of which was *Globigerina* ooze, with *G. pachyderma* dominant, *G. conglomerata*, *G. triloba* and *G. bulloides* less common in this order of frequency. Radiolaria accounted for quite 30 per cent of the residue, the balance being made up of other species of Foraminifera, an extremely long and varied list. *Lagenae* very varied, but few specimens of each species. A great number of interesting rarities and several new species were obtained at this station.

WS 468. TS 645. Fig. I, E I.

9. xi. 29. 55° 52′ S, 56° 53′ W. Sounding, 4344 m.

A small quantity of pale brown-grey mud yielding as residue a pebble, sand grains, *Globigerinae* and Radiolaria. The finer grades of sand contained much glauconite. Quite 95 per cent of the Foraminifera was made up of various species of *Globigerina* and *Globorotalia*, *Globigerina inflata* being dominant. The residue yielded a very long list of species, including many *Lagenae* and several interesting rarities.

WS 469. TS 646. Fig. I, E I.

10. xi. 29. 56° 42′ S, 57° 00′ W. Sounding, 3959 m.

About 30 cc. of pale brown mud yielded a residue of about 10 cc. of fine sand, with some larger grains or pebbles, *Globigerinae* (30 per cent of all), many other Foraminifera and Radiolaria. The pebbles were smothered with *Tolypammina vagans* and a few *Placopsilina confusa*. Six species of *Globigerina* were all common or abundant, *G. inflata* being dominant. Some large rough specimens of *Psammosphaera fusca*, and a long list of other species, many very interesting and some new were obtained.

WS 471. TS 647. Fig. I, E I.

12. xi. 29. 58° 53′ S, 57° 54′ W. Sounding, 3762 m.

A small quantity of light brown mud, yielding a residue of fine sand, diatoms, Radiolaria and some Foraminifera, nearly all arenaceous. The only common species were *Psammosphaera fusca* and *Haplophragmoides subglobosus*. Among the rarer forms were *Spiroplectammina subcylindrica*, *S. filiformis*, *Reophax longiscatiformis*, *Nodellum membranaceum* and *Proteonina tubulata*.

WS 472. TS 663. Fig. I, E I.

12. xi. 29. 59° 42′ 30″ S, 58° 01′ W. Sounding, 3580 m.

A small quantity of dark brown mud giving a residue of fine sand, abundant Radiolaria and diatoms, with few but varied Foraminifera. *Spirolocammina tenuis*, *Ammomarginulina ensis*, *Proteomina tubulata*, *Reophax micaceus*, *Spiroplectammina filiformis*, *S. subcylindrica*, *Bigenerina minutissima*, and *Haplophragmoides nitidus* were among the interesting and rarer forms obtained.

WS 474. TS 648*, 649*. Fig. I, E II.

13. xi. 29. 61° 03′ S, 56° 42′ W. Sounding, 2813 m.

About 40 cc. of dark grey plastic mud yielding a residue of dark grey sand, with a few larger grains and pebbles, many Radiolaria but few Foraminifera. *Haplophragmoides subglobosus* was very common, and there were many fragments of large Arenacea not identifiable with certainty. Although there is a fairly long list of smaller species it contains few forms of outstanding interest.

WS 475. TS 644*. Fig. I, E II.

14. xi. 29. 61° 48′ S, 55° 51′ W. Sounding, 1047 m.

About 60 cc. of fine brown mud which yielded a residue of 20 cc. when washed on 200-mesh silk gauze. The residue was dark grey volcanic sand and ash, and contained too much pumice to be elutriated. Organisms of any kind were scanty, but *Miliammina arenacea* and *M. oblonga* were frequent, and a broken specimen of *Reophax nodulosus* 7 mm. long was observed.

WS 476. TS 666*. Fig. II, G I.

14. xi. 29. 62° 16′ S, 58° 18′ W. Sounding, 542 m.

About 30 cc. of tenacious dark mud gave a residue of 8 cc. fine black and white sand grains, some diatoms and a few Foraminifera. *Nonion depressulus* was the only species occurring with any frequency, most others being represented by one or two specimens only. There were no outstanding rarities.

WS 479. TS 651*. Fig. II, H I.

16. xi. 29. 62° 32′ 30″ S, 57° 55′ W. Sounding, 1523 m.

About 30 cc. of tenacious dark brown mud which, when washed on 200-mesh silk gauze, yielded less than 1 cc. residue of fine sand, diatoms and numerous Foraminifera. Various species of *Miliammina*, *Trochammina bradyi*, *T. malovensis* and *T. globigeriniformis* were very common. Among rarer species were *Proteonina tubulata* and *Vanhoeffenella gaussi*.

WS 480. TS 656. Fig. II, H I.

16. xi. 29. 62° 51′ 30″ S, 57° 47′ 30″ W. Sounding, 740 m.

About 30 cc. of tenacious dark brown mud, which resisted repeated washing and drying, and had eventually to be brushed through a sieve. Residue mainly diatoms, some sand grains and a few pauperate Foraminifera. Various species of *Miliammina* were frequent, and among the more interesting rarities was a single specimen of *Elphidium owenianum*. The only common organism was the ribbon-like object referred to under *Rhizammina algaeformis* (see No. 129).

WS 481. TS 658. Fig. II, H I.

16. xi. 29. 62° 59′ S, 57° 28′ W. Sounding, 453 m.

Less than 1 cc. of muddy sand yielding a residue of sand, shell debris, diatoms and an interesting series of Foraminifera, mostly represented by one or two specimens. The only species occurring with any frequency were *Nonionella iridea*, common, *Globigerina dutertrei*, *Cibicides refulgens*, *Cassidulina crassa* and *Trochammina nana*, all frequent. Among the rarities were *Turritellella shoneana*, *T. laevigata* and *Patellina corrugata*.

WS 482. TS 660, 661, 662*. Fig. II, H II.

16. xi. 29. 63° 10′ S, 57° 16′ 30″ W. (*a*) Sounding, 152 m.; (*b*) Material from townets, 50–0 and 100–0 m.

The bottom sample (*a*) consisted of about 20 cc. dark muddy sand, with a residue of pebbles, sand, polyzoan fragments and diatoms. Foraminifera varied but not numerous, with the exception of *Cassidulina crassa* and *Nonionella iridea*, both common, *Virgulina schreibersiana*, *Cassidulina subglobosa*, *Cibicides refulgens*, *Discorbis vilardeboanus* and several species of *Nonion*, all frequent. Many interesting species among the rarer forms. The material from the townets (*b*) which had touched the bottom consisted of stones, many of them bearing sessile Foraminifera, notably *Webbinella farcta*, Polyzoa, sand and mud. The organisms were essentially similar to those in sample (*a*).

WS 483. TS 675. Fig. II, G I.

21. xi. 29. 62° 46′ 45″ S, 59° 37′ 30″ W. Sounding, 1420 m.

A small quantity of dark brown mud, which left a residue of black volcanic ash felted with diatoms on 200-mesh silk. Foraminifera varied but not very numerous, the only common species being *Recurvoides contortus*, *Miliammina obliqua* and *Trochammina globigeriniformis*. Among the rarer forms were *Ammobaculites foliaceus*, *Textularia wiesneri*, *T. antarctica*, *Thurammina papillata* and *T. castanea*.

WS 484. TS 677. Fig. II, G I.

21. xi. 29. 62° 54′ S, 59° 28′ W. Sounding, 1008 m.

A small quantity of dark brown mud, leaving a residue of black volcanic sand with many diatoms and Radiolaria. Foraminifera very rare, except *Miliammina arenacea* which was common. Single specimens of *Thurammina corrugata* and *Tholosina laevis* were among the rarer species found.

WS 485. TS 681. Fig. II, G II.

21. xi. 29. 63° 02′ 30″ S, 59° 17′ W. Sounding, 805 m.

A small quantity of dark mud yielded a residue of dark sand and diatoms with many Foraminifera of varied species. *Miliammina arenacea* and *Bolivina punctata* were the only common forms, other species varying from frequent to very rare. The most interesting record from this station was a single specimen of *Hippocrepina flexibilis*.

WS 486. TS 683*. Fig. II, G II.

21. xi. 29. 63° 11′ 30″ S, 59° 13′ W. Sounding, 787 m.

About 40 cc. of tenacious dark brown mud left a residue of only 2 cc. on 200-mesh silk: fine sand, diatoms, sponge spicules and a few Foraminifera of the usual local species. The only outstanding species were *Ehrenbergina pupa* and *Bathysiphon capillaris*.

WS 487. TS 685. Fig. II, G II.

22. xi. 29. 63° 17′ S, 59° 20′ W. Sounding, 790 m.

About 30 cc. of tenacious dark grey mud gave a residue of about 2 cc., chiefly diatoms, sponge spicules, sand grains and many Foraminifera. *Miliammina arenacea*, *Bolivina punctata*, *Virgulina schreibersiana* and *Nonionella iridea* were common, other species mostly rare. The only noteworthy rarity was *Ehrenbergina parva*.

WS 488. TS 706*. Fig. II, E II.

22. xi. 29. 63° 51′ 30″ S, 62° 30′ W. Sounding, 220 m.

About 30 cc. of dark mud yielded 8 cc. of residue, composed of dark sand grains of all sizes and a few pebbles. Organic remains scanty, but about thirty species of Foraminifera were recorded. *Miliammina arenacea*, *M. lata*, *M. obliqua* and *M. oblonga* were all frequent or common, as also were *Trochammina nana* and *Virgulina bradyi*. All other species very rare, the only outstanding record being a single specimen of *Miliammina circularis*.

WS 489. TS 703. Fig. II, E II.

22. xi. 29. 63° 38′ S, 62° 32′ W. Sounding, 308 m.

A few cc. of dark grey mud gave a residue of fine volcanic sand, diatoms, Radiolaria, very few Foraminifera, and those pauperate. *Virgulina bradyi* was the only species represented by more than one or two specimens.

WS 490. TS 702. Fig. II, E II.

22. xi. 29. 63° 24′ 30″ S, 62° 35′ 30″ W. Sounding, 262 m.

Less than 1 cc. of dark grey sand, with grains of varying sizes, yielded fifteen species of Foraminifera, generally represented by one or at most two specimens. The only exception was *Uvigerina angulosa*, which was evidently dominant in the deposit as seven specimens were recorded. All the species were normal local forms.

WS 493. TS 691. Fig. II, F I.

23. xi. 29. 62° 51′ S, 60° 34′ W. Sounding, 220 m.

About 2 cc. of black volcanic sand. Foraminifera extremely rare and pauperate, even the common local species represented at most by a few specimens. The ubiquitous genus *Miliammina* was absent. Nothing of outstanding importance.

WS 494 A. TS 696. Fig. II, F II.

28. xi. 29. 63° 15′ S, 61° 05′ W. Sounding, 1035 m.

About 80 cc. of pale brown mud giving a residue of scoriae and pebbles, with very few organic remains. Foraminifera few in number but varied and interesting. *Tolypammina vagans*, which was frequent on the pebbles, and *Recurvoides contortus* were the only common species. Among rarer species were *Placopsilinella aurantiaca*, *Thurammina corrugata*, *T. cariosa* and *Turritellella shoneana*.

WS 494 B. TS 699. Fig. II, F II.

28. xi. 29. 63° 37′ 30″ S, 61° 16′ W. Sounding, 505 m.

About 7 cc. of dark sandy mud giving a residue of dark sand and pebbles. Very few Foraminifera, only *Miliammina arenacea* occurring with any frequency. The only species calling for special notice was *Vanhoeffenella oculus*.

WS 495. TS 734. Fig. I, C III.

22. xii. 29. 67° 47′ S, 73° 51′ W. Sounding, 2582 m.

A small quantity of dark grey mud with very little residue, sand grains, Radiolaria, diatoms and Foraminifera. The only species occurring in any abundance were *Psammosphaera fusca* and *Haplophragmoides subglobosus*. *Cyclammina orbicularis* and *C. pusilla* were frequent, as also were several other species of *Haplophragmoides* and *Clavulina communis*. Among the rarer forms were *Reophax communis* and *Trochammina globulosa*.

WS 496. TS 732. Fig. II, A VI.

30. xii. 29. 67° 14′ S, 70° 12′ W. Sounding, 631 m.

A small quantity of tenacious grey ooze was washed twice and gave a residue principally of diatoms, a few sand grains of varying sizes, many Radiolaria and a few Foraminifera, pauperate but varied. *Miliammina* spp., *Virgulina bradyi* and *Globigerina pachyderma* alone were common, most others rare or very rare. A single specimen of *Robertina arctica* was the only outstanding record.

WS 497. TS 731. Fig. II, A VI.

1. i. 30. 67° 05′ S, 70° 40′ W. Sounding, 534 m.

A small quantity of refractory grey mud was washed twice and gave a residue, principally diatoms with a few sand grains and Foraminifera. These were mostly very small and pauperate, but varied. *Miliammina lata*, *M. arenacea*, *Reophax scorpiurus*, *Virgulina bradyi* and *Globigerina pachyderma* were all common; *Reophax spiculifer* was frequent; most other species rare or very rare. Among them were *Hyperammina friabilis*, *Cystammina argentea* and *Lagena hispida*.

WS 498. TS 722. Fig. II, B V.

2. i. 30. 66° 21′ S, 69° 01′ W. Sounding, 398 m.

A very small quantity of muddy sand gave a residue of small pebbles and sand grains. Foraminifera very scanty but varied. *Globigerina pachyderma*, *Bulimina aculeata*, and *Virgulina bradyi* were the only species occurring with any frequency; about twenty other species represented by one or two specimens only, none of particular interest.

WS 499. No Station slide. Not marked on map.

3. i. 30. 65° 45′ S, 67° 18′ W. Sounding, 179 m.

A pinch of dark grey sand yielded a worm tube with a specimen of *Pullenia subcarinata* imbedded, and *Crithionina mamilla* attached to the tube.

WS 502. TS 739. Fig. I, A III.

30. i. 30. 69° 43′ S, 99° 38′ W. Sounding, 4224 m.

A small quantity of very tenacious brown mud was washed twice and left a residue of fine sand, mud pellets and many Arenacea. Except for four specimens representing three species of *Globigerina*, none but arenaceous species were seen. *Haplophragmoides subglobosus* was the only species occurring in any numbers. Less common were *Cyclammina cancellata*, *C. pusilla*, *Psammosphaera fusca*, *Haplophragmoides glomeratus*. All the other species very rare, sometimes only one or two specimens. They included *Hormosina lapidigera*, *Spiroplectammina subcylindrica*, *Spirolocammina tenuis* and *Thurammina papillata*.

WS 503. TS 740. Fig. I, A IV.

30. i. 30. 70° 03′ 30″ S, 100° 39′ W. Sounding, 4072 m.

A small quantity of tenacious brown mud was washed twice and gave a very minute residue of fine sand and Radiolaria, with a few large Foraminifera and many small species, all very pauperate. *Haplophragmoides subglobosus*, *Cyclammina pusilla* and *Ammomarginulina ensis* were common. No *Globigerinae* were seen. The remaining species were mostly deep-water Arenacea, the only noteworthy forms being *Ammobaculites foliaceus* var. *recurva* and *Spiroplectammina subcylindrica*.

WS 505. TS 738. Fig. I, B IV.

4. ii. 30. 70° 10′ 30″ S, 87° 46′ W. Sounding, 1500 m.

A small quantity of tenacious brown mud which was washed twice, and gave a residue of small pebbles with *Placopsilina confusa* and *Tolypammina vagans* attached, angular sand grains of all sizes, *Globigerinae* and a long list of other Foraminifera. *Globigerina pachyderma* and *G. conglomerata* formed nearly 90 per cent of the residue, and most of the remaining species were the normal associates of an Antarctic *Globigerina* ooze. Among the rarer species were *Ammobaculites foliaceus* var. *recurva*, *Thurammina castanea*, *Bolivina cincta*, *B. decussata*, *B. spinescens*, *Ehrenbergina hystrix* var. *glabra* and *Rupertia stabilis*.

WS 506. TS 735. Fig. I, B IV.

7. ii. 30. 70° 31′ S, 81° 36″ W. Sounding, 584 m.

A small quantity of brown mud with residue of angular sand grains of all sizes, abundant *Globigerinae* and many other Foraminifera. *Globigerina pachyderma* and *G. conglomerata* were dominant; *Miliammina lata* and *M. arenacea* common. A number of interesting rarities, *Bathysiphon argenteus*, *Reophax micaceus*, *R. spiculifer*, *Virgulina schreibersiana* var. *complanata*, *Bolivina spinescens*, *B. cincta* and six species of *Lagena*.

WS 507 A. TS 736. Fig. I, B IV.

8. ii. 30. 70° 32′ 30″ S, 81° 42′ W. Sounding, 572 m.

A small quantity of tenacious mud was washed twice and gave a residue of sand grains of all sizes, many *Globigerinae*, fragmentary Arenacea, and many other Foraminifera of varied species, mostly represented by few specimens. Many large Arenacea were present in recognizable fragments, but there were few perfect specimens. *Miliammina lata*, *Bulimina aculeata*, *Globigerina pachyderma* and *G. conglomerata* all common, the last two dominant in the gathering. A long list of other species, but none of outstanding interest.

WS 507 B. TS 737. Fig. I, B IV.

8. ii. 30. 70° 34′ S, 81° 55′ W. Sounding, 580 m.

A small quantity of pale brown mud yielding a residue of angular sand grains and *Globigerinae*, also other Foraminifera of varied species, but many of them represented by single or few specimens.

Globigerina pachyderma and *G. conglomerata* were dominant. Among the common species were *Rhabdammina discreta*, *Bulimina aculeata* and *Uvigerina angulosa*. Rarer forms included *Reophax micaceus*, *R. spiculifer*, *Thurammina spumosa*, *Verneuilina bradyi* var. *nitens*, *Textularia catenata* and several species of *Lagena*.

WS 509. TS 724. Fig. II, B VI.
11. ii. 30. 67° 18′ S, 69° 28′ W. Sounding, 445 m.
A small quantity of tenacious dark grey mud, with a residue of fine angular sand, diatoms and a few Foraminifera of the common local species. *Miliammina arenacea*, *M. lata* and *Reophax scorpiurus* only were common. No very noteworthy species except *Reophax micaceus* and *Thurammina papillata*.

WS 510. TS 723. Fig. II, B VI.
11. ii. 30. 67° 11′ S, 69° 46′ W. Sounding, 505 m.
A small quantity of greenish-grey mud. Residue sand grains of all sizes, diatoms (*Coscinodiscus*) and a few Foraminifera, *Miliammina* spp. and *Virgulina bradyi* being common. *Saccorhiza ramosa*, *Reophax subfusiformis*, *Haplophragmoides trullissatus*, *Hormosina ovicula* and *Trochammina bradyi* were frequent, other species very rare. They included some interesting forms, *Reophax micaceus*, *R. spiculifer* and *Hippocrepina oviformis*.

WS 511. TS 730*. Fig. II, A VI.
11. ii. 30. 67° 04′ S, 70° 04′ W. Sounding, 635 m.
A small quantity of greenish-grey mud gave hardly any residue but some diatoms (*Coscinodiscus* sp.) and a few Foraminifera of the usual local species. *Globigerina pachyderma* and *Virgulina bradyi* were very common; *Bulimina aculeata* and *B. patagonica* frequent; everything else very rare. Among the noteworthy forms were *Virgulina schreibersiana* var. *complanata* and *Reophax spiculifer*.

WS 512. TS 729*. Fig. II, A V.
11. ii. 30. 66° 57′ S, 70° 22′ W. Sounding, 652 m.
A small quantity of grey mud with a residue of diatoms and many Foraminifera. *Miliammina* (four species), *Globigerina pachyderma* and *Virgulina bradyi* were very common; *Proteonina difflugiformis*, *Saccorhiza ramosa*, *Reophax dentaliniformis* and *Textularia tenuissima* frequent; all other species more or less rare. *Proteonina tubulata* was the only species of great interest.

WS 513. TS 728*. Fig. II, A V.
11. ii. 30. 66° 49′ 30″ S, 70° 40′ 30″ W. Sounding, 560 m.
A small quantity of tenacious dark grey mud with a residue of sand grains, diatoms, Radiolaria, sponge spicules and a few Foraminifera. *Globigerina pachyderma* and *Miliammina* spp. were common, *Virgulina bradyi* frequent, most other species very rare, and none of special interest.

WS 514. TS 727. Fig. II, A V.
11. ii. 30. 66° 40′ 30″ S, 71° 01′ W. Sounding, 531 m.
A small quantity of dark grey mud with a residue of angular sand grains, diatoms, Radiolaria and a few Foraminifera. A considerable and varied list of species, none being very common, and many very rare. Among the interesting species were *Cystammina argentea* and *Textularia antarctica*.

WS 515. TS 726*. Fig. II, A V.
11. ii. 30. 66° 32′ 30″ S, 71° 20′ 30″ W. Sounding, 512 m.
A small quantity of dark grey mud giving a residue of angular sand, Radiolaria, diatoms and scanty Foraminifera. These were varied and chiefly arenaceous, the only species occurring with any frequency being *Miliammina oblonga*, *M. lata*, *Reophax scorpiurus*, *Hormosina ovicula* var. *gracilis* and *Virgulina bradyi*. *Globigerina pachyderma* was rare; *G. bulloides* and *G. triloba* each represented by a single specimen. The other species were nearly all rare or very rare, among them being *Reophax spiculifer*, *Hyperammina novae-zealandiae*, and fragments of *Marsipella cylindrica*.

WS 516. TS 725. Fig. II, A V.

12. ii. 30. 66° 25′ 30″ S, 71° 38′ 30″ W. Sounding, 2611 m.

A small quantity of tenacious though sandy brown mud. It did not clean readily and was washed twice. The residue was mainly a coarse angular sand, with a little fine sand, some Radiolaria and few but very varied Foraminifera, all with arenaceous shells except *Globigerina pachyderma*, which was frequent, and one specimen of *Cibicides refulgens*. Most of the species were represented by a single specimen or a few at most. Among the more interesting were *Gaudryina ferruginea* and *Trochammina globulosa*.

WS 517. TS 733*. Fig. II, A V.

12. ii. 30. 66° 17′ 30″ S, 71° 57′ W. Sounding, 2770 m.

A small quantity of brown mud with a residue of small pebbles, angular sand grains, many Radiolaria and Foraminifera. Quite a long list of species but most of them rare, or even represented by single specimens. Among the rarities were *Placopsilinella aurantiaca*, *Marsipella cylindrica*, *Thurammina spumosa*, *T. murata*, *Reophax sabulosus*, *Ehrenbergina hystrix* var. *glabra*, *Bathysiphon argenteus* and *Reophax communis*.

WS 552. TS 627 C*. Fig. I, J III.

3. ii. 31. 68° 53′ S, 13° 03′ W to 68° 50′ S, 13° 03′ W. Sounding, 4845 m.

42 cc. of grey mud, leaving 1·25 cc. of residue on 200-mesh silk: quartz sand with many Radiolaria and cosmopolitan Arenacea. A single very small specimen of *Cassidulina crassa* was the only Foraminifer apart from the Arenacea.

This station is not very far from Scotia Sts. 420 and 421.

WS 553. TS 627 B*. Fig. I, J III.

4. ii. 31. 66° 14′ S, 15° 34′ W. Sounding, 5029 m.

50 cc. of grey plastic mud leaving less than 1 cc. on 200-silk gauze. Radiolarian ooze with very few Foraminifera, all arenaceous except *Globigerina pachyderma*, and generally of cosmopolitan deep-water species.

WS 555. TS 627 A*. Fig. I, J II.

6. ii. 31. 60° 27′ S, 19° 36′ W. Sounding, 3850 m.

36 cc. of grey mud, less than 5 cc. remaining after washing on 200-mesh silk gauze. Residue almost entirely arenaceous Foraminifera of cosmopolitan species, the only exceptions being single specimens of *Globorotalia truncatulinoides* and *Globigerina inflata*; *Clavulina communis* was common, *Verneuilina bradyi* very rare. Many unquestionably fossil *Globigerinae* were present, only *Globigerina pachyderma* being identifiable with certainty owing to erosion and infiltration.

No Station no. TS 716. Fig. II, E III.

12. xii. 29. Port Lockroy, Wiencke Island, Palmer Archipelago. Anchor mud.

About 20 cc. of dark slate-coloured mud, yielding a residue of fine angular sand with much mica, some diatoms and a few Foraminifera. *Trochammina malovensis*, *T. ochracea* and *T. rotaliformis* were all very common; *Verneuilina advena*, *Textularia nitens*, and *Spiroplectammina biformis* frequent; other species very rare and none of particular note.

No Station no. No Station slide. Not on map.

1. ii. 30. 70° 01′ S, 100° 39′ W, very near St. WS 503. Obtained from an iceberg.

About a quarter of a pint of light grey mud gave a residue of small pebbles and angular sand grains of all sizes, without any trace of organic remains—not even diatoms.

LIST OF NEW GENERA, SPECIES AND VARIETIES

Spiroloculina pusilla
Astrorhiza polygona
Bathysiphon argillaceus
Pilulina arenacea
Sorosphaera socialis
Technitella bradyi
Webbinella farcta
Thurammina corrugata
Thurammina spumosa
Hyperammina tubulosa
Botellina goësii
Reophax bicameratus
Reophax micaceus
Haplophragmoides quadratus
Recurvoides, gen.n.
Recurvoides contortus
Ammobaculites agglutinans var. *filiformis*, var.n.
Ammobaculites foliaceus var. *recurva*, var.n.
Placopsilinella, gen.n.
Placopsilinella aurantiaca
Ammoflintina, gen.n.
Ammoflintina trihedra
Trochammina alternans
Trochammina conica
Trochammina discorbis
Trochammina grisea
Trochammina inconspicua
Trochammina tricamerata
Cystammina argentea
Ammocibicides, gen.n.
Ammocibicides pontoni (not from Antarctic)
Ammocibicides proteus
Spirolocammina, gen.n.
Spirolocammina tenuis
Spiroplectammina filiformis
Spiroplectammina subcylindrica
Spiroplectella, gen.n.
Spiroplectella cylindroides
Textularia paupercula
Verneuilina superba
Gaudryina deformis
Gaudryina minuta
Gaudryina pauperata
Delosina complanata (not from Antarctic)
Delosina polymorphinoides (not from Antarctic)
Delosina sutilis
Delosina wiesneri
Pseudobulimina, gen.n.
Cassidulina lens
Ehrenbergina parva
Lagena basireticulata
Lagena clowesiana, nom.n.
Lagena deaconi
Lagena glans
Lagena guntheri
Lagena heronalleni
Lagena johni
Lagena lagenoides var. *debilis*, var.n.
Lagena marginata var. *spinifera*, var.n.
Lagena palliolata
Lagena pseudauriculata
Lagena quadrilatera
Lagena quadrilatera var. *striatula*, var.n.
Lagena semilineata var. *spinigera*, var.n.
Lagena sidebottomi, nom.n.
Lagena globosa var. *setosa* var.n. (not from Antarctic. See No. 342)
Nodosaria communis var. *larva*, var.n.
Polymorphina scoresbyana
Globigerina megastoma
Discorbis translucens
Heronallenia gemmata
Cibicides grossepunctatus
Cibicides refulgens var. *corticata*, var.n.
Eponides bradyi, nom.n.
Eponides sidebottomi

SYSTEMATIC ACCOUNT

Note. To economize space no synonyms are given for species which have been described in the two previous reports. For purposes of reference, the Falklands and South Georgia numbers are printed in brackets after the specific name, e.g. 15. *Miliolina bosciana* (d'Orbigny) (F 16) (SG 15).

Order FORAMINIFERA

Family MILIOLIDAE

Sub-family *MILIOLININAE*

Genus **Pyrgo**, Defrance, 1824

1. **Pyrgo depressa** (d'Orbigny) (F 2).

Ten stations: 170, 181, 182, 190, 196; WS 468, 469, 481, 482, 506.

Frequent at Sts. 181, 196, rarer elsewhere. Some enormous specimens were seen, the largest at St. 181 being over 3·0 mm. in diameter.

2. **Pyrgo murrhyna** (Schwager) (F 3) (SG 1).

Nine stations: 384, 385; WS 204, 205, 403, 468, 469, 505, 517.

Rare or very rare except at Sts. 385 and WS 469, where it is frequent. These are also the only stations at which well-developed specimens occurred; elsewhere they were small and feeble. All the stations are in deep water, between 1500 and 4344 m., and some of them are outside the Antarctic convergence line.

3. **Pyrgo bradyi** (Schlumberger) (SG 3).

Two stations: 170, 181.

Rare at both stations; the best and most typical specimens at St. 181 in 160 m.

4. **Pyrgo comata** (Brady).

Biloculina comata, Brady, 1879, etc., RRC, 1881, p. 45; 1884, FC, p. 144, pl. iii, fig. 9.
Biloculina comata, Schlumberger, 1891, BGF, p. 565, pl. x, figs. 72, 73, text-figs. 26–8.
Pyrgo comata, Cushman, 1918, etc., FAO, 1929, p. 73, pl. xix, fig. 8.

One station: 363.

A single feebly striate specimen from 329 m., off Zavodovski Island in the South Sandwich group.

5. **Pyrgo sarsi** (Schlumberger) (F 5).

Eleven stations: 170, 175, 177, 182, 186, 385, 386; WS 204, 469, 482, 505.

Rare or very rare except at Sts. 182, 385 and WS 505. The stations show a wide range in depth between 152 and 4773 m., and the largest specimens are found at the shallower stations, particularly fine at Sts. 182 and WS 505. At St. 385, where it is equally common, the specimens are much smaller.

6. **Pyrgo vespertilio** (Schlumberger) (F 10 A) (SG 4).

Three stations: 170, 175, 363.

Frequent typical specimens at Sts. 175 and 363 in 200–329 m. Larger but less typical at St. 170, 342 m.

7. **Pyrgo elongata** (d'Orbigny) (F 6) (SG 6).

Seven stations: 167, 170, 175, 180, 182, 196; WS 482.

Frequent at most of the stations, all of which are of moderate depth—between 100 and 720 m. Very typical specimens generally, especially at St. 167 where the species is rare. At several stations, notably 170 and 182, it attains a comparatively large size, otherwise the specimens are such as would be found in British dredgings.

8. **Pyrgo patagonica** (d'Orbigny) (F 7) (SG 7).

Five stations: 181, 182, 366, 385; WS 482.

Frequent at St. WS 482 at a depth of 100 m., rare or very rare elsewhere. All the stations are in shallow water except St. 385 which is in the Drake Strait, depth 3638 m. Here two very pauperate specimens, doubtfully referable to the species, were found.

9. **Pyrgo peruviana** (d'Orbigny) (F 8).

Five stations: 167, 175, 181, 182, 196.

Large specimens are frequent at Sts. 175 and 182; less common and smaller at the other stations.

10. **Pyrgo globulus** (Bornemann) (F 11) (SG 10).

Three stations: 170, 181, 182.

Common and attaining a large size at all of these stations, the depth ranging between 641 and 710 m.

Genus Spiroloculina, d'Orbigny, 1826

11. **Spiroloculina pusilla**, sp.n. (Plate I, figs. 3, 4).

Spiroloculina tenuis, Brady (*non* Czjzek), 1884, FC, pl. x, fig. 10 (? also fig. 9).
Spiroloculina tenuissima, Cushman (*non* Reuss), 1910, etc., FNP, 1917, p. 32.
? *Spiroloculina tenuis*, Sidebottom (*non* Czjzek), 1918, FECA, p. 5.
Spiroloculina tenuissima, Cushman (*non* Reuss), 1921, FP, p. 400, pl. lxxxiv, fig. 2.

Two stations: 386; WS 204.

A single specimen at each station.

Brady regarded the *Spiroloculina tenuissima* of Reuss (R 1867, FSW, p. 71, pl. i, fig. 11) as synonymous with the *Quinqueloculina tenuis* of Czjzek (C. 1848, FWB, p. 149, pl. xiii, figs. 31–4), a view which has been generally accepted, as the figure of Reuss is distinctly sigmoiline, and where either form is abundant a complete range of specimens joining the two species can usually be obtained. But he was less happy in failing to recognize that the test in both species is always more or less coated with arenaceous investment and is never truly porcellanous. In his figures of *Spiroloculina tenuis* (Czjzek) in the Challenger Report he includes one (possibly two) figures, which are clearly porcellanous *Spiroloculinae*, from deep water in the Atlantic (Challenger St. 332, 2200 fathoms). He appears to have regarded them as pauperate or immature specimens. In the text (B. 1884, FC, p. 152) he writes that "in small delicate specimens the test is commonly Spiroloculine from beginning to end", but he nowhere refers to the nature of the test.

Subsequent authorities have followed Brady, with the result that the little porcellanous species has not, so far as I am aware, been given a specific name. It is well described by Cushman in his Pacific and Philippine monographs. His description is: "Test very thin, translucent, elongate, compressed, in front view tapering towards either end; chambers long and narrow, peripheral margin broadly rounded, chambers in transverse section circular; apertural end produced into an elongate neck, aperture rounded, usually without distinct teeth; wall smooth. Length usually less than 0·5 mm."

The occurrence of the two specimens in the Drake Strait affords an opportunity of naming a very distinctive little species, which appears to be widely distributed all over the world, usually in deep water. Most of the records which can be verified are over 500 fathoms. My specimens are from 3328 and 4773 m.

Genus Miliolina, Williamson, 1858

12. **Miliolina seminulum** (Linné) (F 12) (SG 12).

Eight stations: 170, 175, 177, 180, 181, 363; WS 494A, 494B.

Moderately common at St. 180, rare at 170 and 175, very rare and often represented by a single specimen at the remaining stations. The depth ranges between 160 and 1080 m., and the frequency is generally inversely in ratio to the depth.

13. **Miliolina vulgaris** (d'Orbigny) (F 14) (SG 13).

Eight stations: 164, 170, 177, 181, 182, 186, 196; WS 482.

Frequent or common, and attaining a large size at Sts. 170 and 182, rarer elsewhere. These stations are in 342 and 278 m. respectively, which appears to represent *optimum* conditions for the species, as it is neither so large nor so common in greater or lesser depths. The deepest record is St. 177 in 1080 m. with two average-sized specimens; the shallowest, St. 164 in 24–36 m. with one small specimen.

14. **Miliolina oblonga** (Montagu) (F 15) (SG 14).

Six stations: 167, 175, 180, 181, 366, 385.

Frequent at St. 167, rare or very rare elsewhere. Nearly all the specimens are of a thin-walled almost cylindrical type, the chambers being fragile and readily detachable. With the exception of St. 385, where only a single rather doubtful specimen was observed in 3638 m., the stations were in shallow water with a maximum depth of 244 m.

15. **Miliolina bosciana** (d'Orbigny) (F 16) (SG 15).

Four stations: 170, 175, 385; WS 482.

Not uncommon at St. 170 where the specimens are typical. Single good specimens at Sts. 175 and WS 482, and a single weak individual at St. 385 in 3638 m. The other stations are in moderate depths, 100–342 m.

16. **Miliolina subrotunda** (Montagu) (F 18) (SG 16).

Four stations: 363, 384; Port Lockroy; WS 482.

Single specimens at each station, and all very small.

17. **Miliolina lamarckiana** (d'Orbigny) (F 20) (SG 17).

One station: WS 204.

A single small and thin-walled specimen from 3328 m. This species has a very wide range both in distribution and depth.

18. **Miliolina contorta** (d'Orbigny) (F 21).

One station: 195.

Only a single small specimen was seen.

19. **Miliolina pygmaea** (Reuss) (F 25) (SG 18).

One station: 170.

Only a single specimen was found.

20. **Miliolina venusta** (Karrer) (F 26) (SG 19).

Four stations: 360, 384, 385, 386.

Typical and frequent at St. 385, single typical specimens at the other stations, that at St. 360 being very small. All the stations are in deep water.

21. **Miliolina trigonula** (Lamarck) (F 27).

One station: WS 482.

Only a few weakly developed specimens were observed.

22. **Miliolina tricarinata** (d'Orbigny) (F 28) (SG 20).

Nineteen stations: 170, 177, 363, 384, 385, 386; WS 204, 383, 384, 385, 403, 468, 481, 482, 483, 485, 487, 505, 507 B.

Frequent at St. WS 482, the specimens being of average size; also frequent but very small at St. WS 505. Rare or very rare elsewhere. The stations cover every range of depth. Nowhere do the specimens attain the large size observed in South Georgia, and the aperture is always typically milioline; no specimens with cruciloculine or irregular apertures were observed. At a few stations, notably 177 and WS 505, 507 B, very small and rather elongate individuals were found. It is quite possible that these are not true *Miliolinae*, but microspheric young individuals of the very large species of *Pyrgo* found at the same stations.

Wiesner (W. 1931, FDSE, p. 105) records under the name *Miliolina tricarinata* var. *crucioralis*, nov. var., but does not figure, an organism which from its description appears to be identical with *Cruciloculina triangularis*, d'Orbigny, a synonym of *M. tricarinata* (See F 28).

23. **Miliolina circularis** (Bornemann) (F 29) (SG 21).

Five stations: 167, 170, 177, 186, 360.

Large and typical specimens are not uncommon at St. 170; single smaller individuals at Sts. 177, 186. A few found at St. 167 were small and far from typical, and the single specimen from St. 360 in 3264 m. was extremely small and pauperate.

24. **Miliolina circularis var. sublineata**, Brady.

Miliolina circularis var. *sublineata*, Brady, 1884, FC, p. 169, pl. iv, fig. 7.
Triloculina circularis var. *sublineata*, Cushman, 1910, etc., FNP, 1917, p. 68, pl. xxvi, fig. 2.

One station: 170.

A single large and typical specimen was found.

25. **Miliolina insignis**, Brady (Plate I, figs. 1, 2 and Plate IX, fig. 1).

Miliolina insignis, Brady, 1879, etc., RRC, 1881, p. 45.
Miliolina insignis, Brady, 1884, FC, p. 165, pl. iv, fig. 8, ? fig. 10.
Triloculina insignis, Cushman, 1918, etc., FAO, 1929, p. 64, pl. xvii, fig. 2.

One station: WS 482.

The single specimen figured was found in 50 m. in the Bransfield Strait. It is referred with great hesitation to *M. insignis*, but must be regarded as entirely abnormal, as it has a labyrinthine aperture and exhibits three chambers on each face, the central chamber being more conspicuous on one face than on the other. In spite of this it is probably triloculine and megalospheric, but this could not be verified without sectioning the test.

Apart from the abnormalities it is very like Brady's fig. 8 (*ut supra*). An alternative attribution would be to *Miliolina circularis* var. *sublineata* (No. 24), but its comparatively enormous size and corresponding strength of markings are against this.

26. **Miliolina labiosa** (d'Orbigny) (F 34) (Plate I, figs. 5–7).

One station: WS 517.

A single specimen, very thin-walled, from 2770 m. at St. WS 517. It is almost a facsimile of d'Orbigny's original figure. The species was originally described from shore sand of Cuba, and its occurrence in deep water in the Bellingshausen Sea (66° 17′ 30″ S) is noteworthy. It was recorded by the 'Terra Nova' from the Antarctic, but not by Wiesner, who only reports it at Kerguelen Island.

27. **Miliolina valvularis** (Reuss) (F 35).

Three stations: 170, 175, 363.

A single specimen at each station, very well developed at St. 170; very small at the other stations.

Genus Sigmoilina, Schlumberger, 1887

28. **Sigmoilina obesa**, Heron-Allen and Earland (F 38) (SG 22).

Four stations: 170, 363; WS 202, 469.

Very rare, but good specimens were found, the best at St. 170 in 342 m. The species does not appear to have an extremely southern range, the highest latitude being about 61°, but it seems to be at home in all depths down to 3959 m. at St. WS 469, where the single specimen found was well developed and quite typical.

29. **Sigmoilina schlumbergeri**, A. Silvestri (F 39).

One station: WS 517.

A single small specimen, doubtfully attributed to this species, was found at a depth of 2770 m.

30. **Sigmoilina tenuis** (Czjzek) (F 40) (SG 23).

Six stations: 384, 385, 386; WS 204, 403, 469.

Frequent at Sts. 384, 385, rare or very rare elsewhere. All the stations are in deep water between 3328 and 4773 m. in the Drake Strait and Scotia Sea. The narrow type of Czjzek is very rare, single specimens only occurring as a rule. The general form is extremely complanate, exactly resembling the figure of *Spiroloculina tenuissima*, Reuss (R. 1867, FSW, p. 71, pl. i, fig. 11), which is unquestionably a *Sigmoilina*, although the sigmoid curve is very much flattened out. There are so many intermediate specimens wherever either form is abundant that it is impossible to separate the species of Reuss from the earlier record of Czjzek.

31. **Sigmoilina sigmoidea** (Brady).

Planispirina sigmoidea, Brady, 1884, FC, p. 197, pl. ii, figs. 1–3, 5 *c*.
Sigmoilina sigmoidea, Schlumberger, 1887, P, pp. 476 and 488 (106 and 118 in reprints), pl. vii, figs. 9–11; text-figs. 1–5.
Sigmoilina sigmoidea, Cushman, 1918, etc., FAO, 1929, p. 50, pl. xi, figs. 5–6.

Six stations: 181, 384, 385, 386; WS 204, 403.

Typical but very rare everywhere, except at St. 385 where it is frequent. All the stations are in deep water between 3328 and 4773 m., except St. 181 where a single specimen was found at 335 m.

Sub-family *HAUERININAE*

Genus **Tubinella**, Rhumbler, 1906

32. **Tubinella funalis** (Brady) (F 41) (SG 24).

Three stations: 167, 190; WS 482.

Frequent and very large at Sts. 190 and WS 482; only a single specimen at the other station.

Genus **Planispirina**, Seguenza, 1880

33. **Planispirina irregularis** (d'Orbigny) (F 43) (SG 25).

Six stations: 175, 177, 180, 181; WS 494A, 517.

Rare or very rare everywhere, the best and largest specimens at Sts. 175 and WS 517; elsewhere they are usually small. Those found at St. 175 are large and nearly spherical in shape, approaching *P. sphaera* from the same station very closely.

34. **Planispirina sphaera** (d'Orbigny) (F 44) (SG 26) (Plate IX, fig. 2).

Three stations: 170, 175, 363.

Large specimens are frequent at St. 170, rare at the other stations. The labyrinthine aperture generally developed in large specimens was rarely seen, the general form of aperture being a simple curved slit, nearly closed by a large plate-like tooth. At St. 170 a fragment of what must have been a very large individual had a coarsely cribrate aperture of an unusual character, a photograph of which is given.

35. **Planispirina bucculenta** (Brady) (F 45) (SG 27).

Nine stations: 170, 175, 177, 182, 190, 362, 363; WS 403, 482.

Common at Sts. 170, WS 482; rare or very rare elsewhere, often only a single specimen. All but two of the records are from less than 350 m., the exceptions being a large and well-developed individual from St. 177 in 1080 m., and a few very small and pauperate tests from Sts. 362 (3370 m.) and WS 403 (3721 m.). These last are so thin-walled as to be semi-transparent when dry and iridescent when wetted, the shell being a mere film covering the chitinous lining.

36. **Planispirina bucculenta var. placentiformis** (Brady) (SG 28).

Two stations: 170; WS 482.

Much rarer than the type at both stations.

Sub-family *PENEROPLIDINAE*

Genus **Cornuspira**, Schultze, 1854

37. **Cornuspira involvens** (Reuss) (F 46) (SG 29).

Six stations: 170, 175, 177, 190; WS 482, 515.

Rare or very rare everywhere. Both megalospheric and microspheric individuals were found, but never at the same station except at St. 190. The microspheric specimens often attain a moderately large size, but all the megalospheric individuals are very small.

38. **Cornuspira selseyensis**, Heron-Allen and Earland (F 48) (SG 30).

One station: WS 482.

Three good specimens, all megalospheric, were found at St. WS 482.

39. **Cornuspira foliacea** (Philippi) (F 50) (SG 31).

Four stations: 164, 167, 170; WS 482.

Only a few specimens at each station, fairly large at St. WS 482. They are all of the original type of Philippi, in which the width of the tube increases but slowly, as compared with the rapid development of width shown in Williamson's figure of the species.

40. **Cornuspira diffusa**, Heron-Allen and Earland (SG 32).

Two stations: 167, 366.

Not uncommon at St. 167, where characteristic fragments of small specimens were frequent. One similar fragment from a large specimen was found at St. 366.

Genus **Gordiospira**, Heron-Allen and Earland, 1932

41. **Gordiospira fragilis**, Heron-Allen and Earland (SG 33).

One station: 167.

Well-developed specimens were frequent at St. 167, off the South Orkney Islands, depth 244–344 m. Its absence from any other gathering is rather remarkable.

The genus has been recorded recently from the north-east coast of Greenland, a very striking illustration of widely separated distribution (*Gordiospira arctica*, Cushman, 1933, NAF, p. 3, pl. i, figs. 5–7). The Arctic species appears to be almost identical with the South Georgia type.

Genus **Spirophthalmidium**, Cushman, 1927

42. **Spirophthalmidium acutimargo** (Brady).

Spiroloculina acutimargo (pars), Brady, 1884, FC, p. 154, pl. x, fig. 13.
Spirophthalmidium acutimargo, Cushman, 1925, etc., LFR, 1927, p. 37, pl. viii, fig. 5.
Spirophthalmidium acutimargo, Cushman, 1918, etc., FAO, 1929, p. 90, pl. xxii, fig. 1.

One station: WS 403.

A single specimen from a depth of 3721 m. Although very small, it exhibits in perfection the spiral coil following the proloculus and preceding the series of alternate chambers, on which Cushman established the genus *Spirophthalmidium*. This is probably a "farthest south" record for a species which has a wide distribution.

Genus **Ophthalmidium**, Zwingli and Kübler, 1870

43. **Ophthalmidium inconstans**, Brady (F 51).

One station: 363.

A single excellent specimen was found in 329 m.

44. **Ophthalmidium margaritiferum**, Heron-Allen and Earland (Plate I, figs. 8, 9).

Ophthalmidium margaritiferum, Heron-Allen and Earland, 1922, TN, p. 72, pl. i, figs. 9–12.

One station: 177.

A single specimen from St. 177 in the Bransfield Strait in 1080 m. The shell wall is thick and the sutural lines inconspicuous. The proloculus does not extend in the form of a boss as in the original types, but this appears to be due to the thickness of the wall, as the specimen when examined in fluid proved to have a large proloculus, and otherwise agreed structurally with the type, which was found in Terra Nova dredgings off the north end of the North Island, New Zealand. Its occurrence in the Antarctic is noteworthy.

Family ASTRORHIZIDAE

Sub-family *ASTRORHIZINAE*

Genus **Astrorhiza**, Sandahl, 1857

45. **Astrorhiza limicola**, Sandahl (SG 34).

Two stations: 170, 182.

A single poor specimen at St. 170, and two large specimens at St. 182, constitute the only records. None of them is very typical, fine mud only being used for construction, without the usual admixture of large sand grains, etc.

46. **Astrorhiza crassatina**, Brady (SG 35).

Seven stations: 362, 382; WS 471, 472, 474, 495, 517.

Specimens are frequent at Sts. WS 495, 517, though usually fragmentary. At Sts. WS 471, 472, 474 very large specimens were obtained and many fragments noted. All the stations are in deep water in the Scotia and Bellingshausen Seas.

47. **Astrorhiza triangularis**, Earland (SG 36).

Three stations: 181, 182, 204.

Rare at Sts. 181, 182, which lie in the Palmer Archipelago. Only a single large and rough specimen from St. 204 in the Bransfield Straits. The specimens attain rather larger dimensions than in South Georgia, some exceeding 0·2 mm. in diameter, and are less neatly constructed, the incorporation of a few large sand grains often spoiling the symmetry of the test.

48. **Astrorhiza polygona**, sp.n. (Plate I, figs. 13, 14).

Two stations: 177, 196.

Test polygonal in outline, compressed, thinner at the edges than in the centre; consisting of a single large chamber enclosed by a thin wall of sand and mineral grains neatly and firmly cemented together. At more or less irregular intervals, the marginal edge is drawn out into a variable number of conical tubes, which terminate in simple round apertures.

This very interesting species is based upon a few specimens from the Bransfield Strait. Two were found in a small quantity of muddy residues obtained from nets (N 70 V) at a depth of 720 m. at St. 196. A broken specimen was found in dredge washings from St. 177 in 1080 m. Two soundings were also received for St. 196, but yielded no other examples. In view of the small quantity of material obtained from the nets, it seems possible that the species may be not uncommon at that station.

The two specimens found at St. 196 are not identical, one being almost geometrically regular in its pentagonal outline and the spacing of its tubes, five in number, while the other is less neatly constructed and has six tubes extending from the margin, and an accessory tube projecting from one face of the test. The broken specimen from St. 177 is even less regular in outline. The maximum diameter of the pentagonal specimen is 1·60 mm. and of the other 2·20 mm.

A. polygona is evidently allied to *A. triangularis*, having the same large body cavity compared with the whole mass of the shell. The test, however, is more inflated, neater and more regular in construction and the tubes more definite.

There is a general resemblance to *Vanhoeffenella gaussi* in contour and the construction of the tubes, and the species may prove to be a link between the two genera.

Genus **Pelosphaera**, Heron-Allen and Earland, 1932

49. **Pelosphaera cornuta**, Heron-Allen and Earland (SG 59) (Plate I, fig. 12 and Plate IX, figs. 3, 4).

Two stations: 181; WS 482.

A single broken specimen was found at St. WS 482 in the Bransfield Strait. At St. 181 in the Palmer Archipelago, five excellent specimens, two of which were taken directly from the alcohol in which they had been preserved on the ship, and mounted in canada balsam, show that the projecting processes which in dry specimens appear as hollow cones of mud, are in life flexible tubes constructed of fine mud and extending to a length equal to the diameter of the test. At about half length each tube breaks up into a number of smaller tubes, which branch again and so decrease in diameter almost to a vanishing point. The living organism therefore resembles *Astrorhiza limicola* except for its spherical test, and I am removing the genus from the Saccammininae, where it was originally placed, to the Astrorhizinae.

Genus **Iridia**, Heron-Allen and Earland, 1914

50. **Iridia diaphana**, Heron-Allen and Earland (F 52) (SG 37).

Two stations: 163, 164.

A single excellent specimen at St. 164, and two small and doubtful individuals at St. 163. Both stations are in very shallow water (18–36 m.) in the South Orkneys, and the paucity of specimens may be due to lack of suitable material for examination.

Genus **Vanhoeffenella**, Rhumbler, 1905

51. **Vanhoeffenella gaussi**, Rhumbler (SG 38).

Thirteen stations: 170, 175, 177, 180–2, 190, 366; WS 393, 479, 482, 496, 497.

Moderately frequent at Sts. 181, 190, very rare at the remaining stations, nearly all of which are in the South Shetlands area. The range of depth is much greater than in South Georgia, extending down to 1523 m., but the optimum depth is under 200 m. Plastogamy between two individuals was observed at Sts. 170, 190, attachment being obtained by a thread of protoplasm extending from adjacent tubes.

52. **Vanhoeffenella oculus**, Earland (SG 39).

Five stations: 194, 198, 365; WS 385, 494B.

Two specimens at St. WS 385, and one at each of the other stations, the depths ranging between 505 and 1838 m.

It is worth recording that, since the species was described, I have found a specimen in one of my dredgings from the "Cold Area" of the Shetland-Faroe Channel (Scottish Fisheries cruiser 'Goldseeker', Haul 172, Station XV A, 1280 m., 61° 27′ N, 3° 42′ W). This is the first record of the occurrence of the genus outside Antarctic Seas.

Genus **Pelosina**, Brady, 1879

53. **Pelosina variabilis**, Brady (SG 42).

Eight stations: 180–2, 377; WS 383, 384, 395, 403.

Very common and attaining a large size, sometimes 15 mm., at Sts. 181 and 182, frequent at St. 180. All these stations are in the Palmer Archipelago in 160–812 m. At the remaining stations it is more or less rare and often fragmentary. The deepest record is at St. WS 403, where a single good specimen with a test composed of *Globigerina* ooze was found in 3721 m.

54. **Pelosina variabilis var. constricta**, Earland (SG 43) (Plate IX, figs. 8–10).

Seven stations: 170, 181, 182, 186, 363; WS 383, 482.

Relatively gigantic specimens are not uncommon at St. 181 in the Palmer Archipelago, ranging up to 40 mm. in length. They have been figured in the South Georgia report (pl. i, figs. 14, 15). Smaller specimens are frequent at St. 186, also in the Palmer Archipelago. At the remaining stations, which are scattered between the South Sandwich Islands and the Bransfield Strait, the specimens are small and very rare. The specimen figured by Wiesner under the name *Pelosina variabilis* (W. 1931, FDSE, pl. vi, fig. 69) is unquestionably referable to var. *constricta*.

55. **Pelosina arborescens**, Pearcey (Plate IX, fig. 5–7).

Pelosina arborescens, Pearcey, 1914, SNA, p. 1001, pl. i, figs. 1–5.
Pelosina arborescens, Cushman, 1918, etc., FAO, 1918, p. 56, pl. xxiii, figs. 1, 2.

One station: 181.

St. 181 in the Palmer Archipelago, depth 160–335 m., was notably rich in the genus *Pelosina*. Among the specimens obtained were four more or less perfect individuals of Pearcey's species, with dichotomously branching arms. Owing to the extreme fragility of these extensions, it is probable that many broken specimens were included in the fragmentary *Pelosinae* which formed a large proportion of the gathering. Such broken specimens without extensions would not be distinguishable from *P. variabilis*, which is recorded as very common at this station. It is even a question whether *P. variabilis* is a true species at all, or merely a mutilated or undeveloped condition of *P. arborescens*. Pearcey also hints at this theory in his description of the species.

P. arborescens was first described and figured from 2620 fathoms in the Weddell Sea, but better specimens had previously been obtained from shallow water on the west coast of Scotland, and elsewhere in the North Sea.

It seems to me probable that the extraordinary organism figured and described by Pearcey under the name *Hyperammina palmiformis* (P. 1888, FFC, p. 171, pl. iii) is only *Pelosina arborescens* using *Globigerina* ooze instead of mud for the construction of its dichotomously branching test. It certainly is not a *Hyperammina*, and it has no essential points of difference from *Pelosina arborescens* except the thinner wall of the test. If their identity were proved, the earlier name *palmiformis* would have priority over *arborescens*.

56. **Pelosina cylindrica**, Brady.

Pelosina cylindrica, Brady, 1884, FC, p. 236, pl. xxvi, figs. 1–6.
Pelosina cylindrica, Chapman, 1914, FORS, p. 60, pl. ii, fig. 10.
Pelosina cylindrica, Pearcey, 1914, SNA, p. 1002.
Pelosina cylindrica, Cushman, 1918, etc., FAO, 1918, p. 54, pl. xxii, fig. 5.
Pelosina cylindrica, Heron-Allen and Earland, 1922, TN, p. 77.
Pelosina cylindrica, Wiesner, 1931, FDSE, p. 83, pl. vi, figs. 66, 67.

Five stations: 167, 181, 182, 194, 196.

Rare, but excellent specimens were obtained at all the stations which are confined to the area between the South Orkneys and the Palmer Archipelago, in depths of 160–812 m. This species, which is usually confined to deep water, appears to be indifferent to depth in the Antarctic Seas. Chapman's records are from 121–330 fathoms in the Ross Sea, and the 'Terra Nova' specimens, also from the Ross Sea, were from 45–250 fathoms. On the other hand Pearcey's records from the Weddell Sea are from 1410–2620 fathoms, and Wiesner found it off Kaiser Wilhelm's Land at depths ranging from 385 to 3410 m.

57. **Pelosina rotundata**, Brady (SG 40).

Two stations: 180; WS 203.

Small specimens are not uncommon at St. 180 in the Palmer Archipelago, depth 160 m. At the other station, WS 203, in the deep water of the Scotia Sea (4259 m.), a single large specimen was found, with a test composed of diatoms and Radiolaria.

58. **Pelosina fusiformis**, Earland (SG 41).

Two stations: 167, 177.

Rare, but quite typical at St. 167, off the South Orkneys, in 244–344 m. At St. 177 in the Bransfield Strait, 1080 m., a single very large specimen with a prominent neck at each extremity. The test is almost entirely composed of mud, a few small sand grains being neatly incorporated. It is nearly three times the size of the South Georgia types, measuring 6·0 mm. in extreme length, of which the fusiform body accounts for 4·0 mm. and the extended necks for 2·0 mm. The maximum breadth is about 3·0 mm.

The absence of the species from other stations is remarkable considering its frequency in some of the South Georgia material.

Genus **Storthosphaera**, F. E. Schulze, 1875

59. **Storthosphaera depressa**, Pearcey (F 53).

Two stations: 167, 170.

A single typical specimen at St. 167; rare but less typical at St. 170.

60. **Storthosphaera elongata**, Cushman (SG 44).

Two stations: 170, 366.

Good specimens were frequent at both stations.

Genus **Crithionina**, Goës, 1894

61. **Crithionina granum**, Goës (F 54) (SG 46).

Three stations: 170, 175, 180.

Moderately frequent at Sts. 170, 180; very rare at St. 175. There is a certain variability in the construction at the different stations, very large sand grains and spicules being intermingled with the usual fine sand at St. 170, finer sand grains and spicules being used at St. 175, while at St. 180 hardly anything but the finest sand is employed.

62. **Crithionina mamilla**, Goës (F 55) (SG 47).

Seven stations: 170, 175, 177, 180–2; WS 499.

A few specimens only at most of the stations, but owing to the nature of the gatherings, the species may be commoner than the comparative rarity of specimens would indicate. Very fine spicular outgrowths on specimens at Sts. 177, 180, 181.

63. **Crithionina pisum**, Goës (F 56) (SG 48).

Nine stations: 164, 170, 177, 180, 181, 190, 196; WS 395, 495.

Usually rare or very rare, but small specimens were frequent at St. WS 395 in the Bransfield Strait. The size of the specimens and method of construction vary greatly, but mud is the usual constituent. The best examples of mud-built specimens, some very large, were found at Sts. 181, WS 495. Mud and sand grains formed the material of a very large specimen at St. 177. Very fine white sand was used at St. 170.

64. **Crithionina pisum var. hispida**, Flint (SG 49).

Two stations: 181; WS 482.

Represented by a few good specimens at St. 181, and a single specimen at St. WS 482. They are all small.

Genus **Dendronina**, Heron-Allen and Earland, 1922

65. **Dendronina arborescens**, Heron-Allen and Earland, var. **antarctica**, Heron-Allen and Earland (Plate I, fig. 11).

Dendronina arborescens var. *antarctica*, Heron-Allen and Earland, 1922, TN, p. 80, pl. ii, figs. 13, 19.

Two stations: 177, 181.

A single very fine and perfect specimen, sessile on a zoophyte fragment, was found at St. 181 in the Palmer Archipelago, depth 160–335 m. At St. 177 in the Bransfield Strait, depth 1080 m., two large fragments representing the columnar portion of the organism were observed. At the same station, sessile on a pebble, was a flat outspread growth, white in colour like other sessile organisms at this station, which may represent the basal pad. It has a large circular opening near the edge from which the outstanding column may have been broken. The variety was originally described from 160 to 300 fathoms in McMurdo Sound, in the Ross Sea sector of the Antarctic.

66. **Dendronina limosa, Heron-Allen and Earland, var. humilis, Heron-Allen and Earland.**

Dendronina limosa var. *humilis*, Heron-Allen and Earland, 1922, TN, p. 81, pl. ii, figs. 7–9.

One station: 386.

A few fragments, apparently the tubular portion, were found outside the Antarctic convergence at St. 386 in the Drake Strait, depth 4773 m. The variety was originally described from comparatively shallow water (180–200 fathoms) off Oates Land in the Ross Sea sector of the Antarctic.

67. **Dendronina papillata** (Heron-Allen and Earland) (F 59) (SG 50).

Five stations: 170, 177, 181, 182, 195.

Specimens in all stages of development are not uncommon on pebbles at St. 177 in the Bransfield Strait, depth 1080 m. Otherwise the species is represented at the remaining stations only by single specimens in the earliest stage of growth.

Sub-family *PILULININAE*

Genus **Pilulina**, Carpenter, 1870

68. **Pilulina jeffreysii**, Carpenter (Plate I, fig. 18, and Plate IX, figs. 11–13).

Pilulina, Carpenter, 1870, ODSD, p. 5.
Pilulina jeffreysii, Carpenter, 1881, M, p. 560, fig. 319 *d*, *e*.
Pilulina jeffreysii, Brady, 1884, FC, p. 244, pl. xxv, figs. 1–6.
Pilulina jeffreysii, Flint, 1899, RFA, p. 266, pl. v.
Pilulina jeffreysii, Cushman, 1918, etc., FAO, 1918, p. 52.

Two stations: 170, 175.

No specimens of *P. jeffreysii* were found in any of the soundings or dredgings, but a few very large specimens picked out of the sieves on board ship were received in spirit. St. 170 is off Clarence Island, about midway between the South Orkneys and South Shetlands, depth 342 m. St. 175 is in the middle of the Bransfield Strait, depth 200 m. It seems likely that the species may be widely distributed in the area, but the chance of securing such a large and fragile organism in the sounding tube is very small. Some of the specimens are as much as 7·0 mm. in diameter, which is twice the size recorded by Brady. The construction is particularly neat, the acerate spicules of which the test is largely composed being felted together very closely. The specimens which I have dredged off the west coast of Scotland are less neatly compacted.

An abnormal specimen was received from St. 175. It is 12 mm. long and 5 mm. broad, sausage-shaped and slightly collapsed. There is a characteristic aperture at each end. It is probably an instance of the fusion of two individuals which have constructed a joint test, but there is no sign of a junction in the test.

69. **Pilulina arenacea**, sp.n. (Plate I, figs. 15–17).

Two stations: 366; WS 468.

Test monothalamous, spherical or oval in shape; with a thin wall composed almost entirely of fine sand grains and mud, with an occasional sponge spicule embedded, though in contrast with the other species of the genus, *P. jeffreysii*, Carpenter, and *P. ovata*, Cushman, spicules are conspicuous by their absence. Aperture a large slit with more or less puckered edges, conspicuous and projecting. Colour varying between nearly white to dark grey according to the minerals employed for construction. Surface smooth but not highly finished, the larger sand grains projecting slightly above the general level. Size variable, up to rather more than 2·0 mm. diameter in the largest spherical specimen. Oval specimens are about 1·5 mm. in length, 1·2 mm. in breadth.

The description is based upon a few specimens found at St. 366, off Cook Island in the South Sandwich group, depth 155–322 m. The material was a black volcanic sand and the tests have the dark grey colour characteristic of South Sandwich Arenacea.

At St. WS 468 which is in the deep water of the Scotia Sea, 4344 m., a small specimen was found which is probably a young individual of this species. It is almost spherical, white with a dull rough surface, composed of very fine sand and mud with no visible cement. The aperture is a broad slit, perhaps eroded, as it does not project above the surface. Diameter 0·9 mm.

Genus **Bathysiphon**, M. Sars, 1872

70. **Bathysiphon filiformis**, G. O. Sars.

Bathysiphon filiformis, G. O. Sars, 1871–2, HF, p. 251.
Bathysiphon filiformis, Brady, 1884, FC, p. 248, pl. xxvi, figs. 15–20.
Bathysiphon filiformis, de Folin, 1887, B, p. 279, pl. vi, fig. 4 *a–e*.
Bathysiphon filiformis, Pearcey, 1914, SNA, p. 999.
Bathysiphon filiformis, Cushman, 1918, etc., FAO, 1918, p. 27, pl. xi, figs. 4–5.

Five stations: 362, 384; WS 469, 552, 555.

Represented by rare fragments only, mostly of medium-sized individuals, but at Sts. 362 and WS 555 fragments of both medium and very large specimens were found. Except at Sts. 362 and 384, where fragments of the normally smooth type were found, all the specimens are constructed of mineral grains sufficiently large to be observable in the outer covering. Pearcey has already drawn attention to a similar abnormal method of construction in the ‘Scotia’ specimens from the Weddell Sea, and accounted for it by their environment of glacial mud. All the records are from very deep water, 3370–4845 m.

71. **Bathysiphon capillaris**, de Folin (SG 51).

Twenty stations: 171, 177, 180–2, 196, 362, 366; WS 384, 393, 395, 403, 472, 479, 482, 486, 515, 517, 552, 553.

Generally distributed, frequent at Sts. 171, 181, 366, WS 479, 482, rare or very rare at the other stations. The best and largest specimens were found at St. 196 in 720 m., where it is rare. Beyond 2000 m. it is as a rule represented only by one or two fragments. At several stations, notably Sts. 171, WS 479 and 486, the specimens are dark in colour owing to the incorporation of volcanic sand.

72. **Bathysiphon rufus**, de Folin (SG 53).

Five stations: 198, 363, 369; WS 494 A, 555.

Very rare everywhere. A single good specimen at St. 363 in the comparatively small depth of 329 m., and fragments at St. 369 in 1767 m., both in the South Sandwich Islands. Fragments only at St. WS 494 A in Bransfield Strait and St. WS 555 in the Weddell Sea. A very slender and nearly black specimen, found at St. 198 in the Bransfield Strait, is probably referable to this species, its colour being due to the incorporation of fine black volcanic sand.

73. **Bathysiphon rufescens**, Cushman (SG 52).

Three stations: 167, 181, 196.

The organism referred, in the South Georgia report, with some hesitation to Cushman's species, is common and well developed at St. 167, less frequent at St. 196, and rare at St. 181.

74. **Bathysiphon argenteus**, Heron-Allen and Earland.

Bathysiphon argenteus, Heron-Allen and Earland, 1913, CI, p. 38, pl. iii, figs. 1–3.
Bathysiphon argenteus, Cushman, 1918, etc., FAO, 1918, p. 30, pl. xii, figs. 1–3.
Bathysiphon argenteus, Heron-Allen and Earland, 1922, TN, p. 82.

Two stations: WS 506, 517.

A single large specimen at St. WS 517 and a fragment at St. WS 506. The species, originally described from British waters, has already been recorded from the Antarctic (Ross Sea).

75. **Bathysiphon argillaceus**, sp.n. (Plate I, fig. 10).

Four stations: 177, 180–2.

Test tubular, very long in proportion to its breadth and exhibiting little tapering in the course of growth; wall thin but firm, the cavity occupying quite three-quarters of the external diameter of the shell; composed of very fine mud or clay without incorporation of larger mineral particles; smooth externally but dull and unpolished. Length up to 10·0 mm. or more, average diameter about 0·12 mm.

The distribution appears to be confined to the Bransfield Strait and Palmer Archipelago in depths 160–1080 m. It is more or less common at most of the stations where it occurs. In life and while moist it is flexible, but very brittle when dry. Owing to the clay used in construction the test is quite opaque when mounted in balsam. At St. 181 many specimens were found with a loosely aggregated mass of mud at one end, apparently material in course of collection for enlarging the tube.

A smaller, but probably identical, organism has been familiar to me for many years in my 'Goldseeker' dredgings from the central North Sea, where it occurs at several of the muddier stations, notably St. 9 (61° 34′ N, 2° 4′ E, 370 m.). I have found it also in the Norwegian fjords, so it probably has a wide distribution in cold water.

Sub-family *SACCAMMININAE*

Genus Sorosphaera, Brady, 1879

76. **Sorosphaera confusa**, Brady (SG 54) (Plate I, fig. 25).

One station: 170.

A single specimen, small but quite typical, from 342 m. at Clarence Island.

77. **Sorosphaera depressa**, Heron-Allen and Earland (SG 55) (Plate I, figs. 19–21).

Twenty-two stations: 170, 175, 177, 180, 181, 182, 201, 204, 206, 377; WS 201, 382, 387, 393, 403, 475, 482, 484, 485, 488, 494A, 514.

Generally distributed, except in the Bellingshausen Sea, which furnishes only one record—at WS 514, where it is very rare. St. 175 in the Bransfield Strait is the only locality where the species is at all frequent, but a large number of specimens were collected altogether. In the majority of cases these were single-chambered free individuals, and the shape varies more than the South Georgia illustrations suggest, from very flat cake-like to roughly spherical tests. The latter are often attached to a single sand grain, which apparently gives them no alternative but to grow upwards and outwards in an inflated form. Both sessile and free individuals often occur at the same station, as at Sts. 170, 175, 181, WS 387, 482, 484. The best sessile colonies were found at Sts. WS 387, 482. Moderately shallow water seems most favoured, but specimens were found at all depths down to 4134 m. It is probable that the species is more widely distributed than the records suggest, as stones suitable for its growth were not common in the soundings received.

Cushman in his recently published paper on Arctic Foraminifera (C. 1933, NAF, pp. 1, 2) suggests that this species probably belongs to the genus *Urnula*, Wiesner, 1931, and should be known as *Urnula depressa* (Heron-Allen and Earland). But our species has not a single point in common with the minute organism ascribed to *Urnula*. It has no aperture, and no chitinous base, and the "accidental openings" in our figure (pl. v, fig. 21), to which he refers as similar to those in his figure of *Urnula arctica*, are purely fortuitous, the drawing having been made from a damaged specimen.

78. **Sorosphaera socialis**, sp.n. (Plate I, figs. 22–24, and Plate II, fig. 1).

Four stations: 170, 175, 181, 182.

Test large, free or sessile, composed of a variable number of individual chambers without external apertures associated in a colony, composed of a single layer of chambers, but without apparent means of communication between the chambers. Walls thin but very firm, built of rather coarse sand with abundant ferruginous cement, smoother externally than internally. Shape of the individual chambers variable, but generally speaking rounded, modified by contact and becoming somewhat hexagonal. Colour dark brown. All the specimens found are free, but several show signs of having been sessile before detachment.

Size of colonies up to 3·0 mm. in diameter, individual chambers between 0·2 and 0·8 mm. Very rare at all the stations, the best being Sts. 170, 175. The largest specimen was found at St. 181. The depths range from 200 to 500 m.

The species differs from *S. confusa* in its spreading habit, the colony consisting of a single layer of chambers, instead of an associated mass as in *S. confusa*, which also does not use ferruginous cement. It differs from *S. depressa*, which has a similar spreading habit of growth, in its firmly cemented wall constructed of large sand grains with ferruginous cement. *S. depressa* uses only the finest sand without ferruginous cement, the individual chambers are larger and are never so closely packed together.

Associations of a few individuals are less closely compacted than larger colonies, thus preserving to some extent the shape of the individual chambers. This is evidently very variable, as in *S. depressa*. Two young specimens from St. 175 approach the cylindrical in form, others at 170 and elsewhere flat and cake-shaped, or entirely irregular. A colony of four individuals at St. 182 is nearly circular and quadripartite, very like the figure of *S. depressa* in the South Georgia report (pl. v, fig. 20), but the separate chambers are not deeply separated as in that figure.

Genus **Psammosphaera**, F. E. Schulze, 1875

79. **Psammosphaera fusca**, Schulze (F 60) (SG 56).

Seventy stations: 161, 164, 169, 170, 175, 177, 180–2, 186, 187, 191, 196–8, 203, 204, 206, 360, 363, 366, 373, 377, 383–6; 62° 57′ S, 60° 20′ 30″ W; WS 199, 201, 203–5, 377, 382, 385–7, 389, 394, 400, 403, 468, 469, 471, 472, 474, 481, 482, 484, 485, 488, 493, 494 A, 495, 502, 503, 505, 506, 507 A, 507 B, 509, 512, 514–7, 552, 553, 555.

Generally distributed in all areas and at all depths, often very common. As usual there is great variety in form, due to the greater or less degree of selective power shown. The most widely distributed form in all the areas is somewhat roughly constructed, very large sand grains being used, and the interstices neatly filled in with smaller grains, the result being an irregularly shaped test. This form is common at Sts. WS 495, 552 and frequent at Sts. 203, 373, 384, WS 203, 382, 389, 403, 472, 488, 506, 507 A, 555. Very large specimens at Sts. 373, WS 495. It is similar to those figured in the Falklands report, pl. viii, fig. 3, and apparently the same as *Psammosphaera irregularis*, Wiesner (W. 1931, FDSE, p. 80, pl. iv, fig. 34), which I have not considered worth separating even as a variety.

Second in point of numbers and width of distribution is the normal spherical type, in which sand grains of approximately equal size are strongly cemented together with ferruginous cement, giving a brown colour to the test. This form is common at Sts. 170, 383, 385, WS 469, 482, and frequent at St. 175. As a rule one form or the other predominates at a station, but at Sts. 180, WS 471, 517 they occur together and in equal abundance. The peculiar variety which was figured in the Falklands report (pl. viii, figs. 1, 2), utilizing only a few very large sand grains, is very rare, but was observed at Sts. WS 494 A and 516. Sessile specimens occurred at many stations and were noticeably common at Sts. 180, WS 201, 482. Associated or double shells were observed at Sts. 383, WS 469, 474 and 552.

80. **Psammosphaera fusca var. testacea** Flint.

Psammosphaera fusca var. *testacea*, Flint, 1899, RFA, p. 268, pl. viii, fig. 2.

Psammosphaera fusca var. *testacea*, Heron-Allen and Earland, 1912, etc., NSG, 1913, pp. 17–18, pl. ii, fig. 9.

Psammosphaera testacea, Cushman, 1918, etc., FAO, 1918, p. 38, pl. xv, figs. 1–3.

Three stations: 385; WS 204, 469.

A few excellent specimens were found at Sts. WS 204 and 469, in the deep water of the Scotia Sea, depth 3328–3959 m., and a single small specimen at St. 385 in Drake Strait, depth 3638 m.

81. **Psammosphaera parva**, Flint (SG 57).

Eighteen stations: 167, 171, 180, 181, 362, 369; Port Lockroy; WS 199, 383, 385, 474, 476, 479, 483, 484, 486, 496, 517.

Widely distributed over the whole area, and very common or common at Sts. 167, WS 383, 474 and 517; rare or very rare elsewhere. A double specimen was found at St. WS 383. Specimens of the selective variety formed round a sponge spicule are rare, probably because sponge spicules are not an important element in most of the material; they were observed at Sts. 180, 181, WS 385 and 486.

Genus **Psammophax**, Rhumbler, 1931

82. **Psammophax consociata**, Rhumbler (Plate II, figs. 2–5).

Psammophax consociata, Rhumbler, in Wiesner, 1931, FDSE, p. 81, pl. iv, figs. 38–40, pl. v, figs. 41–3, ? 44.

Psammophax consociata, Cushman, 1928, etc., F, 1933, p. 73; IKGF, pl. ii, fig. 7.

Four stations: 170, 175; WS 482, 502.

Rare or very rare at all the stations, all but one of which are in moderate depths, 100–342 m. Two specimens, quite typical of Wiesner's figs. 39, 41, were found at St. WS 502 in 4224 m. The finest specimens, running up to an association of five chambers, were found at St. WS 482 in 100 m.

Rhumbler's material was obtained from soundings made by the 'Gauss' while frozen in off Kaiser Wilhelm's Land, 200–385 m., where *Psammophax* was abundant. It was not found elsewhere. He regards his genus as a transition stage between *Psammosphaera* and *Saccammina*, and apparently intended to make three species of the series figured, but Wiesner has grouped them all under the specific name *consociata*.

Owing to the scarcity of specimens in the Discovery material it is impossible to form any serious opinion on the value of *Psammophax* as a genus, and I am using it with some hesitation. Wiesner's photographs show a remarkable diversity of form and arrangement of the roughly spherical chambers. It seems to me impossible to separate the earliest stage, which admittedly has no aperture, from *Psammosphaera fusca*, or the bilocular stage, in which two individuals are joined and an aperture formed between them, from what have been regarded hitherto as abnormal double shells of *Psammosphaera*. Agglomerations of more than two chambers may be either nearly straight, in which case, as Wiesner points out, *Reophax cushmani* (F 88) is very similar; or curved, when they are only separable from *Sorosphaera* by the greater thickness of the wall.

Genus **Saccammina**, M. Sars, 1868

83. **Saccammina sphaerica**, M. Sars (SG 60).

Twelve stations: 167, 170, 175, 366, 373, 386; WS 199, 201, 400, 471, 474, 482.

Generally rare but frequent at St. 167 in shallow water (344 m.) in the South Orkneys, where the specimens are small. It is also frequent at St. WS 201 in the Scotia Sea (4134 m.), but here the specimens are large. Depth, however, does not govern the size as some of the largest specimens of all, quite 3·0 mm. in diameter, were found at St. WS 482 (50 m.) in the Bransfield Strait. A single specimen found at St. 366 in the South Sandwich Islands is black, the test being loosely constructed of scoriae. A sessile specimen was found at St. WS 471, with the normal type. At St. WS 199 in the Scotia Sea (3813 m.), in company with specimens of normal size, a fragment nearly 5·0 mm. in diameter and a double specimen 6·0 mm. in length were found. They are roughly built, incorporating very large sand grains.

84. **Saccammina minuta**, Rhumbler (SG 61).

Five stations: 171; WS 469, 472, 494A, 516.

Confined to deep water in the Scotia Sea, Bransfield Strait and Bellingshausen Sea, and always very rare. The best specimens were found at Sts. WS 472 and 516. Except for its comparatively minute size there seems to be little reason for separating this as a species from *S. sphaerica*, but it is noteworthy that the two forms do not occur together at any station.

Genus **Proteonina**, Williamson, 1858

85. **Proteonina difflugiformis** (Brady) (F 61) (SG 62).

Seventy-five stations: 169, 170, 171, 175, 177, 180–2, 186, 187, 191, 194, 196–8, 204, 206, 360, 362, 363, 365, 366, 373, 382, 384–6; WS 199, 203, 204, 377, 382, 383, 385–7, 389, 393–6, 399, 400, 403, 468, 471, 472, 474, 476, 479–83, 485–7, 489, 494A, 496, 497, 502, 503, 507B, 509–15, 517, 552, 553, 555.

Almost universally distributed in all areas and at all depths. It is common at Sts. 169, 181, 186, WS 199, 395, 552, 553; frequent at Sts. 175, 180, 362, WS 383, 385, 471, 472, 479, 480, 512, 517; more or less rare at the remaining stations. There is great variety in the size and method of construction. The most abundant form is a coarsely built organism, pear-shaped and without produced neck, similar to Brady's fig. 5 (B. 1884, FC, pl. xxx, fig. 5). This is ascribed by Cushman (C. 1910, etc., FNP, 1910, p. 42) and Thalmann (T. 1932, NCE, p. 299) to Berthelin's *Haplophragmium* (= *Proteonina*) *lagenarium* (B. 1880, FAM, p. 21, pl. i, fig. 2), but on what grounds is not clear. Berthelin's organism is only about one-quarter of the size of Brady's, and has an aperture half the width of its test. This coarsely built form occurs in various sizes, and is very large and roughly built at the series of Sts. 180–191 and WS 395. It is impossible to avoid the suspicion that many of the specimens, both small and large, are primordials of *Reophax scorpiurus* or *R. pilulifer*, whenever the two genera occur together.

The neatly agglutinate tests similar to Brady's figs. 1–3 (B. 1884, FC, pl. xxx) are less frequent but widely distributed. They exhibit an even greater range of variation than is shown in Brady's figures. At St. WS 471, and occasionally elsewhere, heavy mineral or gem grains are used, giving a very handsome appearance to the test. At Sts. 177, 204, WS 377, 494A, 511 specimens with exceptionally long necks were found. They appear to be inseparable from *Lagenammina laguncula*, Rhumbler (R. 1911, etc., FPE, 1911, pp. 92, 111, pl. i, fig. 4; 1913, p. 375), and I do not see any reason for separating such specimens even specifically, much less generically, as the differences are slight and covered by intermediate variations.

A few abnormal specimens were recorded. At St. WS 512, where the small rough type was frequent, an individual with two necks was observed. At Sts. 194, WS 483 and 486 specimens built with abnormal quantities of grey cement and subglobular in shape occurred.

86. **Proteonina tubulata** (Rhumbler) (SG 64).

Twenty stations: 169, 177, 198, 363, 386; WS 199, 204, 383, 384, 386, 400, 403, 471, 472, 479, 494A, 498, 507A, 512, 517.

The stations are widely distributed all over the area, and usually in deep water, though there are four records (Sts. 363, WS 498, 507A, 512) under 1000 m. At most stations only single specimens were found, but five excellent examples were seen at St. WS 472 in 3580 m., and four equally good at St. WS 199 in 3813 m. Considering the extremely fragile nature of the neck, and the fact that if broken away the specimens might easily be mistaken for small *Psammosphaerae*, it is not improbable that the species is much commoner than the records show.

87. **Proteonina micacea**, Cushman.

Proteonina micacea, Cushman, 1918, etc., FAO, 1918, p. 49, pl. xix, figs. 6, 7.

One station: 169.

A few specimens which appear to be referable to Cushman's species. The angular tests are built of flakes of volcanic glass instead of mica.

Genus **Technitella**, Norman, 1878

88. **Technitella bradyi**, sp.n. (Plate II, figs. 7–9).

Technitella melo, Brady (non Norman, 1878), 1884, FC, p. 246, pl. xxv, figs. 7 *a*, *b*.
Technitella melo, Cushman (non Norman), 1918, etc., FAO, 1918, p. 60, pl. xvi, fig. 6.
Technitella melo, Wiesner (non Norman), 1931, FDSE, p. 85, pl. vii, fig. 74.

Three stations: 170, 175; WS 482.

Test monothalamous, flask-shaped, oval or roughly spherical; wall firm and thin, composed of a single layer of sand grains and fragments of large sponge spicules in varying proportions, evenly cemented together; aperture round and simple, with collar of cement seldom produced beyond the body of the test. Size and shape variable, up to 1·0 mm. in length and nearly as much in breadth.

The organism described by Norman (N. 1878, GH, p. 280, pl. xvi, figs. 5–6) under the name *Technitella melo* is very different from that subsequently figured by Brady, Cushman and Wiesner under the same name. Norman's specimen is evidently closely allied to his other species *T. legumen*, differing only in the fact that in the basal half of the test the "minute linear sponge spicules" used for construction "project considerably from the body wall and are invariably directed backwards".

Norman tells us that his specimen was picked out by Brady from 'Porcupine' material, off Rockall, 1215 fathoms, and sent to him by the finder as a "sponge?", and that Brady would not accept it as a Foraminifer. Later, Brady appears to have altered his views, and there may have been some personal feeling over the matter, for he refers to Norman's diagnosis as the description of a specimen rather than of a species, and adopted Norman's name for a very different organism found at Challenger St. 344, off Ascension Island.

It seems probable that Norman's type was merely an abnormal specimen of *T. legumen*, from which it differs only in its flask shape. It has otherwise all the characters of the earlier species. The type is in the British Museum, and the projecting spicules referred to in Norman's description are by no means so conspicuous a feature as his figure suggests.

Brady's organism is much more roughly constructed; local material, whether sand or sponge spicules, is employed, and there is no evidence whatever of the definite selection of suitable spicules for a particular purpose, such as is found in *T. legumen* and *T. melo*, Norman. On the contrary, fragmentary spicules only appear to be used, and they are roughly assembled. It is not surprising therefore that Rhumbler (*vide* Wiesner *ut supra*) was inclined to assign the 'Gauss' specimens to the genus *Saccammina*, under the name *S. ovum*. I have not followed Rhumbler's view for the reason that *Saccammina* is such a well-defined genus, and none of the Discovery specimens shows any tendency to the formation of that distinct neck for the aperture which marks *Saccammina*.

Technitella bradyi is evidently a much more widely distributed organism than *T. melo*, which, so far as can be judged from published figures, appears to be known only from the original locality, off Rockall, 1215 fathoms. The figured records of *T. bradyi* (under the name *T. melo*) are few, but give a range from the tropical Atlantic (Challenger St. 344, off Ascension Island) to the Antarctic (Kaiser Wilhelm's Land). There are several unillustrated records of *T. melo*, but without examination of the specimens it cannot be stated whether they are of Norman's or Brady's type. Incidentally, and for purposes of correction, it may be recorded that the specimens figured as *T. melo* by Heron-Allen and Earland (H.-A. and E. 1909, TNS, p. 409, pl. xxxiv, fig. 9) were subsequently used by them as the types of *Nouria harrisii* (H.-A. and E. 1914, etc., FKA, 1914, p. 376, pl. xxxvii, figs. 16–20).

Technitella bradyi is of frequent occurrence at St. WS 482 in the Bransfield Strait, 0–100 m., and the specimens show great diversity of size and shape, and in the percentage of spicules employed. Three specimens were found at St. 175, also in the Bransfield Strait, 200 m., two of which were mainly of spicular construction, and the other entirely built of sand grains. One good specimen at St. 170, off Clarence Island, 342 m.

Genus **Urnula**, Wiesner, 1931

89. **Urnula quadrupla**, Wiesner (Plate II, fig. 6).

Urnula quadrupla, Wiesner, 1931, FDSE, p. 83, pl. vi, figs. 56, 57.

One station: WS 482.

A few specimens on a stone from 152 m. at St. WS 482. It may possibly be of frequent occurrence elsewhere on suitable material, but was not separated until Wiesner's genus was published.

Cushman (C. 1933, NAF, p. 1, pl. i, figs. 1, 2) has recently described another form *U. arctica*, from north-east Greenland.

I am not convinced that *Urnula* is a Foraminifer, and not the egg-cases of some unknown organism. I have been familiar with similar bodies for many years, sessile on shells and stones from various parts of the world. They vary much in size, and in the number of chambers, often single, but agree in their thin shell, generally chitinous or of cement without admixture of minerals. They are quite as frequently devoid of aperture as furnished with one, and the aperture when present is generally large, as though an organism had emerged after hatching.

Genus Webbinella, Rhumbler, 1903

90. **Webbinella depressa**, Heron-Allen and Earland (F 64) (SG 65).

Five stations: 170, 175, 177; WS 482, 494A.

Many specimens of different sizes at St. 177 in 1080 m. Single examples only at the other stations.

91. **Webbinella limosa**, Earland (SG 66).

One station: 369.

A single specimen on a small pebble from 1767 m., at St. 369 near the South Sandwich Islands.

92. **Webbinella hemisphaerica** (Jones, Parker and Brady) (F 63).

Three stations: WS 482, 507A, 507B.

Very rare, one or two specimens only at each station.

93. **Webbinella farcta**, sp.n. (Plate X, figs. 1–6).

One station: WS 482.

Test arenaceous, large and sessile, more or less circular and hemispherical, the shape varying with the environment. In sheltered depressions it is low-domed, irregularly oval in contour, and with a tendency to spread out at the edges. On exposed surfaces it is compact and high-domed, almost hemispherical. Externally, the test is firmly and smoothly constructed of rather large sand grains embedded in finest grey sand and cement, often with an armature of projecting sponge spicules. Except for its greater size and convexity, and the absence of marginal tubes, it is very similar externally to *Tholosina vesicularis*, but internally it is very different. When the outer test is removed, the cavity is found to be stuffed with very fine sand, in which are a number (up to six) of large oval or spherical cavities filled with dark protoplasm. There is no apparent communication between these cavities, and the sand though firmly compacted is not cemented together, but can be scraped away with a needle point or a wet brush. When the sand is removed, or in abraded specimens, the base of the cavity is found to be covered with a smooth and firmly cemented floor of similar fine sand; flanges of the same material extend from the inner edges of the test towards the interior, but do not extend over the middle of the floor; their purpose is apparently to strengthen the walls of the test.

Greatest diameter of a hemispherical specimen 3·5 mm.; of an irregular specimen nearly 5·0 mm. Height up to 2·0 mm.

This remarkable form was found only at St. WS 482 in the Bransfield Strait, where it was not uncommon on stones brought up in the nets. It was probably very abundant in this locality, which is just off the extreme north end of the Graham Land peninsula.

I broke open several perfect specimens and found them all stuffed with the fine sand and containing the separate protoplasmic bodies. These could be removed with a needle point, and were similar to the bodies extracted from *Pelosina fusiformis* and other Arenacea, apparently protoplasm in a chitinous bag.

I think these separate bodies represent merely a reproductive stage of the organism, as in several abraded specimens the cemented floor of the cavity is covered with masses of dried protoplasm, extending into the flanged cavities of the outer wall. This is even more apparent in a single detached hemispherical specimen which contains a protoplasmic body large enough to have filled the entire cavity during life.

Webbinella farcta probably has a wide distribution in the Antarctic, and perhaps elsewhere in cold water. There are several specimens from Terra Nova and Discovery (1901–4) stations off the Antarctic continent in the Ross Sea, in the Heron-Allen and Earland collection in the British Museum. Their nature was not detected at the time, and they were listed in the Terra Nova report with the sessile specimens of *Crithionina pisum* and *C. mamilla*. They are even larger and more convex than the specimens from the Bransfield Strait, but agree in specific features.

In the same collection is a pebble which I dredged from a depth of 1275 m. in the "Cold Area" of the Shetland-Faroe Channel. (F.C. 'Goldseeker', 14 August, 1910, Haul 221, St. xiv B, 61° 18′ N, 2° 59′ W.) It bears a number of sessile organisms which appear to be allied to *W. farcta*, though perhaps specifically distinct. They are circular in form, but the height is greater than the breadth, like a drum with a superimposed hemisphere. Firmly constructed of fine sand and cement, and bristling with long and fine sponge spicules. Laid open, they are found to have a central cavity packed with fine sand, containing cavities similar to those in *W. farcta*.

Genus **Tholosina**, Rhumbler, 1895

94. **Tholosina bulla** (Brady) (F 65) (SG 67).

Eighteen stations: 163, 164, 167, 171, 175, 177, 180–2, 186; WS 386, 387, 468, 474, 475, 483, 488, 494A.

Except at St. 181 in the Palmer Archipelago, where good specimens are common, the species is rare everywhere. There is, as usual, great variation in the size and nature of the material used for construction, and detached specimens are of frequent occurrence.

95. **Tholosina laevis**, Rhumbler (SG 67) (Plate II, fig. 10).

Tholosina laevis, Rhumbler (nov. spec.) in Wiesner, 1931, FDSE, p. 86, pl. vii, figs. 80–2.

Twelve stations: 163, 177, 181, 182, 186, 196, 377; WS 387, 395, 484, 488, 494B.

Always rare, usually only a single specimen at each station, but more frequent at Sts. 181, 182, 186.

I have separated the species from *T. bulla* with which it was included in the South Georgia report (SG 67), chiefly because it occurs at many stations in company with very typical specimens of that species, and without intermediate forms. Its pure white, highly domed test in such circumstances is very distinctive, in contrast with the much darker tests of *T. bulla* which incorporate large sand grains, but it is doubtful whether the two forms are specifically distinct. The specimens agree with the description as quoted by Wiesner. "Like *T. bulla*, but only built up of fine white cement without noticeable sand grains, the surface is therefore smooth, occasionally wrinkled, or with depressed points." Specimens are between 0·2 and 0·6 mm. in diameter.

96. **Tholosina protea**, Heron-Allen and Earland (F 66) (SG 68).

Five stations: 175, 177, 182, 190; WS 482.

Always very rare; the best specimens at Sts. 175, 182 and 190.

97. **Tholosina vesicularis** (Brady) (F 67) (SG 69).

Fifteen stations: 169, 172, 177, 181, 182, 187, 377, 384; WS 201, 475, 482, 484, 494B, 514, 515.

Frequent at St. WS 494B but rare elsewhere. The rarity is doubtless to some extent due to the lack of pebbles, or other suitable material for attachment, in most of the gatherings. The stations are widely scattered and range down to 4134 m.

Genus **Armorella**, Heron-Allen and Earland, 1932

98. **Armorella sphaerica**, Heron-Allen and Earland (SG 71) (Plate II, figs. 12–14).

Seven stations: 167, 181, 182, 186, 190, 363, 382.

Frequent at St. 181, where excellent specimens were found, some bearing exceptionally long tubes, and others showing the variations due to the use of coarse and fine sand grains which were illustrated in the South Georgia report. At St. 363 in the South Sandwich Islands three specimens were found using angular black volcanic sand which gave them an exceptionally rough exterior. All the stations except one lie in shallow water (93–344 m.) on the shores of the South Sandwich Islands, South Orkney Islands and the Palmer Archipelago, and the species is probably universally distributed in shallow water in these areas. The one exception is a single spherical specimen with many short tubes, found at St. 382 in 3647 m. This station lies off the South Shetlands, and the specimen may have been carried into deep water by ice. Cushman in the second edition of his book on Foraminifera (C. 1928, etc., F, 1933, p. 70) has reduced the genus *Armorella* to a synonym of *Astrammina*, Rhumbler (Rhumbler in Wiesner, 1931, FDSE, p. 77, pl. ii, fig. 19). This is entirely incorrect; the two organisms have only a slight superficial resemblance to each other, and their origins are apparently quite distinct. *Astrammina* would appear to have affinities with *Saccammina* in its firmly cemented shell, while *Armorella* is unquestionably connected closely with *Tholosina*.

I have submitted specimens of *Armorella* to Dr Ludwig Rhumbler and Herr

Wiesner, since Cushman's book was published. They agree that the two genera are distinct.

Genus **Thurammina**, Brady, 1879

99. **Thurammina papillata**, Brady (SG 72).

Sixteen stations: 175, 177, 180, 360, 383; WS 199, 201, 385, 403, 471, 474, 483, 485, 502, 509, 553.

Seldom more than a single specimen at each station, and with very few exceptions confined to deep water, the best specimens being found at Sts. WS 553 (5029 m.), WS 471 (3762 m.). At Sts. 177, WS 385, 485, 509 the single specimens were very small; chitinous at WS 485.

100. **Thurammina castanea**, Heron-Allen and Earland (F 61 A).

Five stations: 170, 177; WS 483, 505, 553.

A single specimen only at each station, the best at Sts. WS 505, 553. A typical but entirely chitinous example at St. 170.

101. **Thurammina haeusleri**, Heron-Allen and Earland (SG 73).

Nine stations: 175, 177, 181, 190, 206, 363; WS 201, 472, 482.

Good specimens at all the stations, but seldom more than one or two at each, except at Sts. 175, 181, where it was more frequent. All the stations are in shallow water except Sts. 177 and WS 201. At the latter an exceptionally large specimen was found in 4134 m.

102. **Thurammina albicans**, Brady (SG 75).

Ten stations: 175, 180–2, 190, 363, 373; WS 199, 495, 507B.

A rare species everywhere, but some excellent specimens were found, the best being at Sts. 181 and 363. A closely allied form differing from *T. albicans* in the irregular form of the test is described as a new species under the name *T. corrugata*. It occurs with *T. albicans* at Sts. 175, 181.

103. **Thurammina corrugata**, sp.n. (Plate II, figs. 15–18).

Seven stations: 170, 175, 177, 181; WS 482, 484, 494A.

Test free, of variable shape, more or less spherical, oval or of entirely irregular form. Surface smooth but not polished, dented, puckered or sometimes deeply corrugated. Furnished with numerous bluntly conical and perforated papillae. Shell firm and moderately thick, composed of very fine mineral grains without visible cement. Colour nearly white. Size variable, up to 1·0 mm. in greatest diameter.

This appears to be a distinctive species. Its colour and the construction of the test indicate affinity with *T. albicans*, but its irregular shape is a constant and characteristic feature. In this respect it evidently bears the same relationship to *T. albicans* as *T. haeusleri* does to *T. papillata*.

Several specimens were found at most of the stations, and in company with *T. albicans* at Sts. 175, 181. The species probably has a wide distribution, as specimens were found at Terra Nova St. 96D off the North Cape, New Zealand, and recorded under the name *T. papillata* var. *albicans* (H.-A. and E. 1922, TN, p. 108).

104. **Thurammina compressa, Brady.**

Thurammina compressa, Brady, 1879, etc., RRC, 1879, p. 46, pl. v, fig. 9; 1884, FC, p. 324, pl. xxxvii, fig. 1.
Thurammina papillata var. *compressa*, Heron-Allen and Earland, 1912, etc., NSG, 1917, p. 545, pl. xxvii, figs. 2–8.
Thurammina compressa, Cushman, 1918, etc., FAO, 1918, p. 73, pl. xxviii, fig. 9.

Four stations: 170, 175, 385; WS 472.

A single specimen at each station, the best at St. 175, but none very typical.

105. **Thurammina cariosa, Flint.**

Thurammina cariosa, Flint, 1899, RFA, p. 278, pl. xxii, fig. 2.
Thurammina papillata var. *cariosa*, Heron-Allen and Earland, 1912, etc., NSG, 1917, p. 550, pl. xxix, figs. 1–11.
Thurammina cariosa, Cushman, 1918, etc., FAO, 1918, p. 72, pl. xxviii, fig. 1.

Five stations: 170, 177, 181; WS 488, 494A.

Several very good and typical specimens were found at St. 170, but only single examples at the other stations.

106. **Thurammina spumosa, sp.n.** (Plate IX, figs. 14–19).

Seven stations: 175, 180–2; WS 482, 507B, 517.

The test, which is irregularly spherical in shape, consists of two parts, an inner spherical shell and its outer vesicular covering. The inner sphere is composed of fine sand grains and ferruginous cement; it is firmly built, rough externally and with a few slightly projecting tubes. Internally it is smooth and polished, and has a few pits which mark openings passing through the wall of the sphere to the external tubes. Surrounding the sphere is an external spongy covering, consisting of extremely fine sand grains without visible cement, enclosing vesicular cavities, which are very large in the proximity of the sphere and decrease in size towards the surface, which is a homogeneous layer of very fine sand drawn out into a large number of vesicular cusps. The spongy external covering is thick, a perfect test being about twice the diameter of its inner sphere. It is very fragile, and most of the specimens found are in a greater or lesser stage of disintegration of the outer covering. Diameter of inner sphere about 0·6–0·8 mm.; of an entire and perfect test about 1·5 mm.

Frequent at Sts. 175 and 181; rare at St. 182; single specimens only at the other stations. The depths range between 100 m. at St. WS 482 and 2770 m. at St. WS 517, but the last is exceptional. All the stations are in the Bransfield Strait and Palmer Archipelago, except St. WS 507B, which is far away in the south of the Bellingshausen Sea.

T. spumosa is a very remarkable organism, and quite unique in the development of its external vesicular coating, the purport of which is not apparent. It is probably a development from *T. cariosa*, Flint (No. 105), but cannot be confounded with that species, even in a denuded condition. The outer "cavernous" layer of *T. cariosa*, referred to by Flint in his description of that species, is thin and equally distributed over the surface of the sphere. The vesicles in that species also are usually quite small, though varying in different specimens. But even the "specimen with coarsely vesiculated cavernous layer" figured by Heron-Allen and Earland in 1917 (H.-A. and E. 1912, etc., NSG, 1917, pl. xxix, fig. 5) cannot be compared with *T. spumosa* in the size of its vesicles. *T. cariosa* occurs in the Discovery material, but with the exception of St. 181, its distribution is different.

107. **Thurammina murata**, Heron-Allen and Earland (Plate II, fig. 11).

Thurammina papillata var. *murata*, Heron-Allen and Earland, 1912, etc., NSG, 1917, p. 549, pl. xxviii, figs. 18–21.

One station: WS 517.

A single quite typical specimen from 2770 m. in the Bellingshausen Sea. Its occurrence so far from the original, and so far as I know the only recorded localities, in the Faroe-Shetland Channel, adds one more to the mysteries of distribution in the Foraminifera.

108. **Thurammina protea**, Earland (SG 76).

Nine stations: 167, 170, 177, 181, 182, 190, 196; WS 482, 494 A.

Frequent at Sts. 182 and 190 in the Palmer Archipelago, but rare elsewhere. Both sessile and free specimens were observed, and in some cases the free specimens indicate by their shape that they have developed inside the cavity of *Hyperammina subnodosa*, or some other tubular organism.

This species may prove to be identical with *Thurammina irregularis*, Wiesner (W. 1931, FDSE, p. 83, pl. vi, figs. 62–4), in which case Wiesner's name has priority. The figures are very similar, but Wiesner says his specimens have no apertures, whereas they are generally distinct in *T. protea*. His description of his species is: "Test of variable, generally irregular shape, shell wall thin, built of tiny flat sand grains with more or less cement. Oral papillae absent, apertures not perceptible. Colour light brown".

T. protea has recently been recorded from 280 fathoms in the Bay of Whales, Ross Sea, by A. S. Warthin (W. 1934, FRS, p. 1).

109. **Thurammina tuberosa**, Haeusler (SG 77).

Two stations: 190; WS 385.

Two small specimens probably referable to Haeusler's species were found at St. WS 385 in the Bransfield Strait, depth 1838 m., and one at St. 190 in the Palmer Archipelago, depth 93–130 m. They resemble the simple aggregations described from South Georgia.

Sub-family *RHABDAMMININAE*

Genus **Jaculella**, Brady, 1879

110. **Jaculella acuta**, Brady (F 69) (Plate II, figs. 19, 20).

Eight stations: 170, 177, 362, 363; WS 494 A, 507 B, 511, 517.

Always very rare, but the few stations at which it was recorded are spread over the whole area from the South Sandwich Islands (St. 363) to the Bellingshausen Sea, and the depths range between 329 and 3370 m. Most of the specimens are small or very small, but at St. 170 two large tests were found. At St. 363 a small individual, 1·2 mm.

long, which I figure, has a well-marked and pointed proloculus formed of chitin with ferruginous cement. A single specimen from St. 362 in the deep water of the Scotia Sea (3370 m.), also figured, is attributed with doubt to this species. Its oval chitinous proloculus is followed by a similar chamber before the conical agglutinate shell begins to be formed. The specimen is only 0·3 mm. in length.

111. **Jaculella obtusa**, Brady (F 70) (SG 78).

Twelve stations: 169, 177, 181, 196; WS 384, 469, 471, 479, 494A, 497, 517, 553.

Widely distributed all over the area, but except at St. 181 in the Palmer Archipelago, where it is frequent in 160–335 m., the species is rare. Most of the records are below 1000 m., and fragments were found in the Weddell Sea at WS 553 in 5029 m., the deepest sounding received. The best and largest specimens were obtained at Sts. 196, WS 469, 494A.

Genus **Hippocrepina**, Parker, 1870

112. **Hippocrepina oviformis**, Heron-Allen and Earland (SG 80).

Two stations: 163; WS 510.

A single good specimen at each station.

113. **Hippocrepina flexibilis** (Wiesner) (SG 81).

Three stations: 190; WS 202, 485.

A single specimen at each station; that from St. WS 202 in the deep water of the Scotia Sea, 3987 m., is much larger than usual. All of them are more or less collapsed owing to the thinness and flexibility of the test.

Genus **Hippocrepinella**, Heron-Allen and Earland, 1932

114. **Hippocrepinella hirudinea**, Heron-Allen and Earland (SG 82).

Three stations: 164, 181, 209.

The rarity of this species, which is so common at some stations in South Georgia, is noteworthy. The records are confined to shallow water in the South Orkneys, South Shetlands and Palmer Archipelago; a single small specimen at St. 209 and very rare at the other stations. The specimens are rather more thick-walled than usual, especially at St. 164, but are otherwise quite typical.

The species is not uncommon in a dredging made by the Irish Fisheries cruiser 'Helga' in 982 fathoms off south-west Ireland (Haul SR 944, 51° 22′ 30″ N, 12° 38′ W). The material used in construction is very fine sand instead of mud, and the resultant test is light coloured and more friable than the South Georgia type.

115. **Hippocrepinella alba**, Heron-Allen and Earland (SG 84).

Four stations: 167, 177; WS 384, 385.

The single specimens found at Sts. 177 and WS 385 in the Bransfield Strait, at depths of 1080 and 1838 m. respectively, were regularly fusiform with an aperture at each end. The walls were not collapsed. The species is more frequent at St. 167 in the South Orkneys, 244–344 m., and the specimens illustrate the wide range of size and form referred to in the South Georgia report. At St. WS 384 a single rather doubtful specimen was found, with a produced neck but no basal aperture.

This species is probably very widely distributed in cold waters, as I have found specimens in a dredging from Hilte Fjord, near Bergen, Norway, 260 m. (F.C. 'Goldseeker', Haul 141).

Genus **Hyperammina**, Brady, 1878

Note. At several stations, notably Sts. 180, 195, WS 394, 474, 476, fragmentary specimens which cannot be identified with any certainty are not uncommon. The majority are probably referable to *Hyperammina*, but other genera such as *Rhabdammina*, *Marsipella* and *Jaculella* may also be involved. They have been disregarded in the preparation of this report.

115A. **Hyperammina friabilis**, Brady (F 71).

Three stations: 363; WS 497, 517.

Found only in the Weddell Sea and Bellingshausen Sea, and always very rare. The best and typical specimens at St. WS 517 in 2770 m. At the other stations, 329–534 m., the specimens are smaller and not quite typical.

116. **Hyperammina elongata**, Brady (F 72) (SG 85).

Twenty stations: 180, 181, 197, 198, 363, 373, 382; WS 201, 203, 377, 383, 385, 395, 471, 498, 507A, 509, 515, 517, 555.

Usually rare or very rare, so far as perfect specimens or identifiable fragments are concerned. The most typical examples were found at St. WS 471 (3762 m.), where the species was very rare. A rough variety constructed of coarse sand grains is frequent at St. 181, and represents the species at most of the other shallow-water stations, but it was also found in 2770 m. at St. WS 517.

117. **Hyperammina laevigata**, J. Wright (F 73) (SG 86).

Five stations: 169, 180, 360, 366; WS 468.

Frequent at St. 169, very rare elsewhere. The majority of specimens are grey, and devoid of that excess of cement which gives the typical form such a polished orange-coloured test.

118. **Hyperammina clavigera**, Heron-Allen and Earland (F 74).

Three stations: 175, 177, 196.

Very rare at all stations. A few excellent specimens in perfect condition were found at St. 175 in 200 m. In the specimens from the other stations the proloculus is missing, but I think there can be no doubt as to their identification. All the stations are in the Bransfield Strait, and the presence there of a species first recorded from the Falklands area, and absent from South Georgia, is clear evidence of the mixture of warm- and cold-water species to be found in the Bransfield Strait, due no doubt to an influx of Pacific water.

119. **Hyperammina novae-zealandiae**, Heron-Allen and Earland (F 75) (SG 87).

One station: WS 515.

Two very small microspheric specimens were found at St. WS 515 in the Bellingshausen Sea, 512 m.

The distribution of this species is remarkable. Originally described in the 'Terra Nova' report from the North Island of New Zealand, where it is common, it was not found by that expedition to the south in the Ross Sea, but turned up again in the Falklands area, in South Georgia, and now in the Bellingshausen Sea. Wiesner did not find it in the Antarctic of Kaiser Wilhelm's Land, but it was recorded as "typical" at 'Gauss' St. 29 (35° 53′ S, 13° 9′ E, off the Cape of Good Hope) in 4970 m., and farther east as "sandy" at 'Gauss' St. 39 (46° 47′ S, 50° 37′ E) in 2320 m. It has therefore nearly encircled the globe. It may be present in the Weddell Sea (see p. 11).

120. **Hyperammina tubulosa**, sp.n. (Plate II, fig. 21).

One station: WS 471.

A broad tube of approximately equal diameter throughout, thin walled, slightly curved, and exhibiting faint rings of growth. The aboral extremity is neatly rounded off and closed, but has not the bulbous proloculus typical of the genus. It is composed of fine mineral grains with excess of cement. The wall is smooth and slightly polished. The aperture is large and round, occupying the whole width of the tube, the edge at the extremity of the tube being bevelled off towards the opening. Colour dark grey. Length 1·90 mm.; greatest breadth 0·32 mm.

A single specimen only from 3762 m. at St. WS 471 in the Scotia Sea. I believe I have found similar specimens in deep-water dredgings made by either the F.C. 'Goldseeker' or F.C. 'Helga', off British coasts, but cannot at present verify the fact.

121. **Hyperammina subnodosa**, Brady (SG 88).

Two stations: 167, 170.

Large and frequent at St. 167 in the South Orkneys in a gathering made by nets attached to trawl in 244–344 m.; only a single broken specimen at St. 170 in dredged sand. The rarity of the species compared with its frequency in South Georgia is noteworthy, but may be due in some measure to the fact that few net-gatherings were made in the Antarctic. Large species such as *H. subnodosa*, which are probably widely separated in the surface mud, have little chance of being taken by a sounding tube.

Genus **Saccorhiza**, Eimer and Fickert, 1899

122. **Saccorhiza ramosa** (Brady) (F 56 A) (SG 89).

Twenty-three stations: 190, 362, 373, 382, 383; WS 199, 393, 400, 403, 468, 471, 472, 474, 494 A, 495, 509, 510, 512, 515, 517, 552, 553, 555.

Generally distributed in all areas, often frequent, and common at two stations, Sts. 190 in the Palmer Archipelago (93–130 m.), and WS 517 in the Bellingshausen Sea (2770 m.). Except in the Bellingshausen Sea, where the stations are generally under 700 m., and the exceptionally shallow record at St. 190, all the records are in deep water, ranging down to 5029 m. At St. WS 471 in the Scotia Sea (3762 m.), where the species was frequent, an exceptionally fine specimen with primordial chamber was found sessile on a large sand grain. As a rule sand grains only are used for building, but highly spiculiferous examples were frequent at St. WS 472, and rarer at WS 474.

Genus **Psammatodendron**, Norman, 1881

123. **Psammatodendron arborescens**, Norman.

Psammatodendron arborescens (Norman MS.), Brady, 1881, HNPE, p. 98.
Hyperammina arborescens, Brady, 1884, FC, p. 262, pl. xxviii, figs. 12, 13, text-fig. 10.
Psammatodendron arborescens, Cushman, 1918, etc., FAO, 1918, p. 79, pl. xxx, figs. 1, 2.

One station, 194.

A single branching fragment, from 812 m., which cannot be mistaken for any other organism.

124. **Psammatodendron indivisum**, Heron-Allen and Earland (F 77) (SG 90).

One station: 206.

Doubtfully represented by one specimen, which is apparently a basal pad with a fragment of the stem attached.

Genus **Marsipella**, Norman, 1878

125. **Marsipella cylindrica**, Brady (F 78) (SG 92).

Ten stations: 386; WS 199, 468, 471, 472, 474, 507A, 515, 517, 555.

Except for rare fragments at St. WS 507A, 515, 517 in the Bellingshausen Sea, the species is confined to the deep water in the Weddell and Scotia Seas and the Drake Strait. It is frequent at St. WS 472 (3580 m.), but rare elsewhere. Specimens using sponge spicules for construction were found at Sts. WS 471, 507A. At St. WS 555 in the Weddell Sea (3850 m.) the tests are abnormally thin and collapsible, a very unusual feature in this species.

Genus **Rhabdammina**, M. Sars, 1869

126. **Rhabdammina abyssorum**, M. Sars (F 79).

Four stations: 161; WS 475, 482, 515.

Fragments of varying sizes only were found, the largest at St. WS 475. The species is probably widely distributed, as fragments were found at other stations which could not be identified with certainty.

127. **Rhabdammina discreta**, Brady (F 80) (SG 93).

Ten stations: 177, 196; WS 494A, 497, 498, 506, 507A, 507B, 511, 514.

The only perfect specimens were a series received in spirit, which had been picked out on the ship from material dredged at St. 177, 1080 m. The species was probably common there as, judging by the numerous fragments, it is at Sts. WS 507A, 507B. Fragments were also frequent at Sts. WS 494A, 497, 506 and 514; rare elsewhere.

128. **Rhabdammina linearis**, Brady.

Rhabdammina linearis, Brady, 1879, etc., RRC, 1879, p. 37, pl. iii, figs. 10, 11; 1884, FC, p. 269, pl. xxii, figs. 1–6.
Rhabdammina linearis, Goës, 1894, ASF, p. 18, pl. iv, figs. 65–6.
Rhabdammina linearis, Cushman, 1918, etc., FAO, 1918, p. 19, pl. vii, figs. 2–5.

Two stations: WS 474, 507A.

Rare at both stations.

Genus **Rhizammina**, Brady, 1879

129. **Rhizammina algaeformis**, Brady (SG 94).

Three stations: 170; WS 497, 513.

Fragments of the branching organism which is the type of Brady's species were found at Sts. 170, WS 497 and 513. They constitute the only reliable record.

The "flat, unbranching, ribbon-like organisms of variable but regular width throughout" which are referred to in the South Georgia report (SG 94) occur at twelve stations, Sts. 167, 194, 196, 197, 362, WS 199, 480, 485, 487, 497, 514, 517, at depths ranging from 244 to 3813 m., and are often very abundant. Their real nature remains unsolved. As transparent objects under a high power they appear to be ribbons, not tubes, encrusted with mud and diatoms. They show no structure or signs of protoplasm and I am not disposed at present to accept them as Foraminifera.

Genus **Aschemonella**, Brady, 1879

130. **Aschemonella ramuliformis**, Brady.

Aschemonella ramuliformis, Brady, 1884, FC, p. 273, pl. xxvii, figs. 12–15.
Aschemonella ramuliformis, Cushman, 1910, etc., FNP, 1910, p. 81, fig. 110.
Aschemonella ramuliformis, Pearcey, 1914, SNA, p. 1005.
Aschemonella ramuliformis, Cushman, 1918, etc., FAO, 1920, p. 2, pl. i, fig. 1.

One station: 181.

A few fragments, probably referable to this organism, were found at St. 181 in 160 m. The depth is the only factor which raises suspicion as to their attribution, all previous records being from deep water. Pearcey recorded it from 2620 fathoms in the Weddell Sea.

Genus **Hospitella**, Rhumbler, 1911

131. **Hospitella manumissa**, Rhumbler (Plate II, fig. 22).

Hospitellum manumissum, Rhumbler in Wiesner, 1931, FDSE, p. 89, pl. viii, fig. 98.

One station: WS 474.

A single specimen on a sand grain from 2813 m. in the Scotia Sea. It has about twenty chambers visible and agrees very well with Rhumbler's description of his species: "Shell irregular, crosier-shaped, spiral primordial, growing end irregular, twisted here and there. Shell wall golden brown, transparent, chitin predominating, with very few sand grains. Chambers irregular, bag shaped, with a neck, about equal size".

I cannot trace any spiral primordial or sand grains in my specimen, which appears to be entirely chitinous. The neck between the separate chambers is short, in most cases only visible as an internal tube passing from one chamber to the next, the walls of the chambers being in actual contact. But in one or two instances there is a distinct space between two chambers traversed by a tube.

The genus was described in 1911 (R. 1911, etc., FPE, 1911, p. 227) under the name *Hospitella*, subsequently amended to *Hospitellum* (R. 1911, etc., FPE, 1913, p. 468). Such corrections in generic names are not admissible and the original name must stand. Wiesner gives the size of his colony as 0·3 mm., but does not mention the size of the individual chambers. The Discovery specimen is rather more than 0·30 mm. in diameter of the colony, the individual chambers vary in size up to 0·06 mm. in diameter.

Genus Botellina, Carpenter, 1869

132. **Botellina goësii**, sp.n. (F 81 A) (Plate II, figs. 23–26).

Botellina labyrinthica, Goës (*non* Brady), 1894, ASF, p. 19, pl. iv, figs. 69–86.
Botellina labyrinthica, J. Wright (*non* Brady), 1902, FRI, pp. 211–12.
Botellina labyrinthica, Heron-Allen and Earland (*non* Brady), 1916, FWS, p. 221.
Botellina labyrinthica, Cushman (*non* Brady), 1918, etc., FAO, 1920, p. 89.
Botellina labyrinthica, Heron-Allen and Earland, 1932, Discovery Reports, vol. IV, p. 336, No. 81 A.

One station: 363.

The organism recorded by us in the Falklands report (*ut supra*) under the name of *B. labyrinthica*, Brady, was found in some numbers at St. 363, off Zavodovski Island in the South Sandwich group, at a depth of 329 m. The specimens are similar to those found at St. 388 off Cape Horn, but are in better condition. They are identical with the organism which is figured and recorded under the same name by Goës, from 35 m. off the Swedish coast, and by J. Wright and Heron-Allen and Earland from various localities in Ireland and Scotland.

Cushman in 1920 has already observed that the figures of Goës are not Brady's species, or at least do not show the full characters. Goës himself refers to the points of difference; his description (translated) is: "Tube-shaped, aperture a simple irregular opening or exhibiting some irregular pores; the interior irregularly cancellate with ridges and sand grains; the primordial end slightly inflated, nearly smooth internally, with a thin wall (sometimes perforated); built of coarse sand, often irregular, slovenly, like a worm tube. My form differs from the type in its smaller size, and the less completely constructed cancellate interior. Colour grey or rusty. Length 10–15 mm."

Goës' description seems adequate, but I think the perforations in the primordial end to which he refers in his text and figures must have been adventitious. I have never seen openings in the bulb, unless in obviously broken specimens.

The type of Goës is so different in size and elaboration of structure from the relatively enormous organism described by Brady, that it is somewhat remarkable that nobody has yet given it a distinctive name. I propose to call it after its first recorder, Dr Axel Goës.

Brady's type of *B. labyrinthica* is known only from deep water in the cold area of the Faroe Channel, whereas *B. goësii* evidently has a very wide distribution in much shallower water. Wright dredged it in abundance midway between Belfast Lough and Portpatrick in 100 fathoms, and I have found it equally common in one of my Goldseeker dredgings in the Moray Firth, at 55 m.

Although less common in the Discovery material, some of the specimens are in excellent condition and show the slightly inflated primordial chamber and the apertural end.

Wiesner (W. 1931, FDSE, p. 100, pl. xiii, fig. 158, pl. xiv, figs. 159, 160) records and figures under the name of *B. labyrinthica* specimens from Kaiser Wilhelm's Land, which are neither *B. labyrinthica* nor *B. goësii*. I think in spite of their size, over 1 inch in one instance, they are *Jaculella acuta*, resembling the specimens figured in the Terra Nova report (H.-A. and E. 1922, TN, p. 85, pl. i, figs. 19, 20). Since the publication of that report I have seen similar specimens collected from shallow water on the Australian coast by Mr W. J. Parr, F.R.M.S., of Melbourne, and have observed the same terminal aggregations of sand in British specimens which were otherwise typical *J. acuta*. The curious form figured and described by Chapman under the name *Botellina radiciformis* (C. 1924, FSA, p. 9, pl. i, fig. 3) is very similar, and possibly a *Jaculella*.

Family LITUOLIDAE

Sub-family *LITUOLINAE*

Genus **Reophax**, Montfort, 1808

133. **Reophax scorpiurus**, Montfort (F 82) (SG 95).

Seventy stations: 164, 169, 170, 171, 175, 177, 180–2, 186, 191, 194–6, 202–4, 360, 362, 363, 365, 369, 373, 377; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; WS 199, 201, 203, 204, 377, 382, 383, 386, 387, 391, 393, 399, 403, 468, 471, 472, 474–6, 480, 482, 484–90, 493, 494A, 494B, 496, 497, 507B, 509–17, 553.

The records are spread over all the areas within the Antarctic convergence line, and include all depths down to 4259 m. at St. WS 201 in the Scotia Sea, but curiously enough the species was represented only by single specimens at Sts. WS 403 and 468 among the deep-water stations in the Drake Strait and Scotia Sea. St. WS 468 is outside the Antarctic convergence line.

There is great variety in the comparative length and breadth of the test at different stations, but the commonest and most widely distributed form is a slender many-chambered test, like de Montfort's original figure. This is very common at Sts. 180 and WS 515, common at Sts. 170, 177, WS 497 and 509 and frequent at Sts. 175, WS 386, 399, 471, 494A and 496. A very rough form occurs at many stations, usually constructed of black volcanic sand and scoriae; such forms are common at Sts. 194, 203 and 363. At St. WS 403 in the Scotia Sea (3721 m.) the species is represented by a single small specimen built up of the tests of other Foraminifera. This variation has been separated by Cushman specifically as *R. agglutinatus* (C. 1918, etc., FAO, 1920, p. 9, pl. ii, figs. 4, 5) and by Wiesner as *R. scorpiurus* var. *testacea* (W. 1931, FDSE, p. 89, pl. viii, fig. 100, pl. ix, fig. 101).

134. **Reophax curtus**, Cushman.

Reophax scorpiurus (*pars*), Goës (*non* Montfort), 1894, ASF, p. 24, pl. v, figs. 160–3.
Reophax curtus, Cushman, 1918, etc., FAO, 1920, p. 8, pl. ii, figs. 2, 3.

Eleven stations: 175, 186, 386; WS 474, 482, 485, 498, 502, 505, 507A, 514.

Cushman has separated the broad and few-chambered form from the long series of *R. scorpiurus* figured by Goës, as the type of a species *R. curtus*. It appears to be fairly characteristic and is the dominant type in the North Sea; it is not necessarily confined to moderate depths as Cushman states.

Records have been kept of its occurrence at ten stations, seven of which are under 1000 m., but the remaining three extend from 1500 to 4773 m. It is frequent at Sts. 186 and WS 474, rare elsewhere. The few specimens found at St. WS 485 are rough and built of volcanic sand. At St. 175 very large specimens were roughly constructed of quartz grains.

135. **Reophax subfusiformis**, Earland (SG 96).

Forty-two stations: 167, 171, 175, 177, 180, 181, 185, 186, 192, 196, 198, 203, 362, 363, 365, 377; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; WS 377, 383, 384, 386, 393, 395, 400, 403, 480, 482, 483, 485–8, 493, 494A, 494B, 496, 509–11, 515, 517.

Generally distributed in all areas, and at all depths down to 4517 m. The species is nowhere so common or so well developed as in South Georgia, being rare or very rare at most stations. The only stations where it occurs with any frequency are Sts. 186, 363, 62° 57′ S, 60° 20′ 30″ W, WS 383, 384, 480, 486 and 510. The best specimens were found at Sts. WS 393, 480 and 486.

136. **Reophax bilocularis**, Flint.

Reophax bilocularis, Flint, 1899, RFA, p. 273, pl. xvii, fig. 2.
Reophax bilocularis, Cushman, 1918, etc., FAO, 1920, p. 10, pl. iii, figs. 3, 4.

Four stations: 167, 386; WS 468, 482.

Very rare at all the stations. Flint's type is built of *Globigerina* ooze; the Discovery specimens are all constructed of mineral grains.

137. **Reophax pilulifer**, Brady (F 82 A) (SG 97) (Plate II, figs. 10, 36).

Forty-one stations: 167, 170, 171, 175, 177, 180–2, 186, 191, 194, 196, 202, 203, 362, 365, 369; 62° 57′ S, 60° 20′ 30″ W; WS 201, 203, 382, 394, 403, 472, 475, 480–5, 487, 493, 494A, 494B, 495, 502, 503, 514, 552, 553.

Widely distributed in all the areas and at all depths down to 5029 m. It is most abundant at stations of moderate depth in the Bransfield Strait and Palmer Archipelago, notably Sts. 175, 181, 182, 186 and WS 482, at all of which it is common or very common and of very large dimensions, in some instances reaching a length of 5 mm. It occurs frequently at Sts. 170, 194, 196, WS 394, 487 and 494A; rare or very rare at the remaining stations. At most stations the specimens are of rough construction with large projecting mineral grains, similar to the figures of *R. robustus*, Pearcey (P. 1914, SNA, p. 1006, pl. i, figs. 6–10), but differing in the absence of the produced neck. It would appear probable that Pearcey's species should be transferred to the genus *Hormosina*. It is noteworthy that no specimens resembling Pearcey's species in the produced neck were found in material from the Antarctic. On the other hand, the specimen recorded from South Georgia (SG 98) is undoubtedly *R. robustus*. Smoothly constructed specimens predominate at some stations, notably Sts. 170, WS 403, 487 and 495. At St. 182

both rough and smooth specimens were found. At many of the Bransfield Strait stations the tests are built of black scoriae, giving an exceptionally rough appearance.

138. **Reophax fusiformis** (Williamson) (F 83) (SG 99).

Twenty-six stations: 167, 169, 171, 177, 180, 192, 195, 198, 200, 202, 209; 62° 57′ S, 60° 20′ 30″ W; WS 383–6, 389, 395, 472, 476, 479, 482, 483, 485, 515, 517.

Widely distributed but generally rare. It is however very common at St. WS 479 in 1523 m., and of frequent occurrence at Sts. 209, WS 384 and 483; the best examples were found at St. 209.

139. **Reophax communis**, Lacroix (Plate II, figs. 29, 30).

Reophax communis, Lacroix, 1930, LPCM, p. 4, text-figs. 5–7.

Seven stations: 360, 373; WS 469, 474, 495, 516, 517.

The few records are confined to deep water in the Scotia and Bellingshausen Seas, between 2515 and 3959 m., and except at St. 360, where it is not uncommon, and WS 516, where it is rare, only one or two specimens were noted at each station. In the Mediterranean, from which it was first described, and in British seas, the species is found in comparatively shallow water, and owing to its minute size it may have been overlooked at other Discovery stations.

140. **Reophax dentaliniformis**, Brady (F 84) (SG 101) (Plate II, figs. 32–35).

Sixty-four stations: 167, 169, 171, 175, 177, 180, 181, 186, 187, 191, 192, 194, 196, 202, 206, 209, 360, 362, 363, 365, 369, 383, 386; Port Lockroy; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; WS 199, 382–5, 387, 389, 393, 395, 403, 471, 472, 474, 476, 479–83, 485–90, 493, 494A, 494B, 496, 497, 506, 509, 510–2, 514, 515, 555.

Generally distributed all over the area, and at all depths down to 4773 m., but most abundant in comparatively shallow water. Brady's type having only five or six chambers is comparatively rare, but was common at St. 363, and records of its occurrence were kept at Sts. 383, WS 471 and 482 also. No doubt it occurs at other stations, but was overlooked in comparison with the local type which is longer and more tapering, the septal lines being less prominent. Large specimens have up to ten or even more chambers, the last with its produced aperture sometimes forming nearly one-half of the test. Both megalospheric and microspheric forms occur, the latter being much more numerous than the former. The megalospheric form is practically identical with Brady's figures, and the question arises whether he was acquainted with the large and slender microspheric form.

The species is extremely common at Sts. 180, 181 and 186, all of which are in comparatively shallow water in the Palmer Archipelago; common at Sts. 196, 363, WS 395 and 479, and frequent at Sts. 175, 209, WS 383, 385, 482, 483, 485, 487, 496 and 514. At the remaining stations it is more or less rare, and in deep water often very small.

141. **Reophax spiculifer**, Brady (SG 100).

Ten stations: WS 377, 496, 497, 506, 507A, 507B, 510, 511, 514, 515.

Frequent at Sts. WS 497 and 506, rare or very rare elsewhere. With one exception, St. WS 377 (2352 m.), the records are from the Bellingshausen Sea in depths between

505 and 635 m. At Sts. WS 377, 506, 507A, 507B the tests are to some extent sandy, spicules being employed only as framework for the chambers. At the remaining stations spicules form almost the entire test, as figured in the South Georgia report (SG 100, pl. ii, fig. 20). The finest specimen, with five chambers, was found at St. WS 511.

142. **Reophax longiscatiformis**, Chapman.

Reophax longiscatiformis, Chapman, 1914, FORS, p. 63, pl. iii, fig. 18.
Reophax longiscatiformis, Heron-Allen and Earland, 1922, TN, p. 95.

Six stations: 170, 198; WS 203, 471, 474, 482.

Only a single fragment at each station. Three chambers in the fragment from St. WS 471 and two, including a long slender proloculus, in the specimen from St. 170. There is great range in the depths, 100 m. at St. WS 482 and 4259 m. at St. WS 203.

143. **Reophax micaceus**, sp.n. (Plate II, figs. 37–40).

Fourteen stations: 169, 194; WS 199, 203, 471, 472, 496, 497, 506, 507B, 509, 510, 515, 552.

Test minute, rigid and fragile, more or less transparent; consisting of 2–6 chambers rapidly increasing in length, the last sometimes produced into a long and tapering neck. Sutures slightly depressed. Constructed of a single layer of mica flakes cemented together by their edges, and without any admixture of sand except at the aperture, which is denser in colour and structure and appears to be strengthened by the use of fine sand. The size of the mica flakes determines the shape of the chambers, which are round in section when the flakes are minute, rather angular when large. Length variable, up to 0·7 mm.

This highly selective little organism is rare or very rare everywhere. Six of the stations are in the deep water of the Weddell and Scotia Seas, between 2514 and 4845 m.; the others are in the Bellingshausen Sea, 505–812 m. It was most frequent at Sts. WS 471 and 472 in the Scotia Sea, where the best specimens were obtained.

It is a matter of some interest that the test of *R. micaceus* does not collapse when dried, but retains its shape, though very fragile. *R. scottii*, also using mica flakes only for construction, invariably collapses on drying and is then very fragile, though in life and when preserved in fluid the chambers are inflated, and the whole test flexible. The flakes used by *R. scottii* are very uniform in size and smaller than in *R. micaceus*, which uses flakes of varying sizes even in a single chamber.

144. **Reophax flexibilis**, Schlumberger (F 86) (SG 102).

Two stations: 192; Port Lockroy.

A single specimen from 800 m. at St. 192, and two from anchor mud at Port Lockroy. They are all small but typical. The stations are not far apart in the Palmer Archipelago.

145. **Reophax nodulosus**, Brady (F 84 A) (SG 103).

Thirty-two stations: 170, 175, 177, 180, 181, 194, 196, 360, 373, 382, 383; WS 203, 386, 393, 400, 468, 471, 472, 475, 482, 488, 495, 498, 502, 505, 506, 507A, 507B, 515, 517, 552, 553.

Occurs in all the areas and at all depths from 50 to 5029 m. Perfect specimens of large size were seldom found in the material as obtained, but a few ranging up to 8 mm. in length which had been picked out from the material when dredged were received in spirit from St. 177 in the Bransfield Strait (1080 m.). Fragments of much larger specimens were found, notably one of four chambers measuring more than 6 mm. at St. WS 495 in the Bellingshausen Sea (2582 m.). The specimen if complete and proportionately built would probably have exceeded an inch in length. Such large individuals however must be very rare, the average large specimen being about 6 mm., and even such are in a minority, the species being represented at most stations by small specimens and fragments of medium size. It is common at St. WS 507A, frequent at Sts. 170, 175, 196, WS 506 and 507B, more or less rare elsewhere. The length of the chamber as compared with its breadth varies greatly. In small specimens the chambers are often very long.

146. **Reophax bicameratus**, sp.n. (Plate II, fig. 27).

One station: WS 507B.

Test composed of two elongate-oval chambers separated by a slight constriction of the body of the test. Aboral end rounded, oral end produced to a blunt point bearing the aperture. Sutural line between the chambers not distinguishable. Composed of fine sand grains neatly cemented together to form a smooth but unpolished surface. Colour pale yellow, darker round the mouth.

Length 1·2 mm.; greatest width and thickness 0·4 mm.

Only a single specimen from 580 m. in the Bellingshausen Sea. It has all the appearance of a fully grown organism, but may prove to be an immature specimen.

147. **Reophax guttifer**, Brady (Plate II, fig. 31).

Reophax guttifera, Brady, 1879, etc., RRC, 1881, p. 49; 1884, FC, p. 295, pl. xxi, figs. 10–15.
Reophax guttifer, Goës, 1894, ASF, p. 26, pl. vi, figs. 192–5.
Reophax guttifer, Cushman, 1918, etc., FAO, 1920, p. 13, pl. iii, fig. 7.

Twelve stations: 177, 180, 181, 186, 369, 386; 64° 56′ S, 64° 43′ W; WS 395, 490, 494A, 507A, 515.

Not uncommon at Sts. 180 and 181 in the Palmer Archipelago, depth 160 m., where some large specimens running up to six or seven chambers were found. Very rare elsewhere, and usually of two or three chambers only, though single large specimens were found at St. WS 515 and in the sounding from 64° 56′ S, 64° 43′ W.

148. **Reophax distans**, Brady (SG 104).

Seventeen stations: 170, 196, 385; WS 386, 468, 469, 471, 472, 474, 495, 497, 502, 503, 507B, 515, 517, 555.

Fragments only of this fragile organism were found, never more than two chambers attached to each other. Such fragments were common at St. WS 472, and frequent at St. WS 474, both of which are in the deep water of the Scotia Sea. The other records show a wide range between 342 and 4344 m., and are scattered over the entire area between the Weddell and the Bellingshausen Seas.

149. **Reophax catenulatus**, Cushman (Plate II, fig. 28).

Reophax catenulatus, Cushman, 1910, etc., FNP, 1910, p. 93, fig. 135.

One station: WS 403.

A single specimen, of two chambers only, from 3721 m. in the Drake Strait. The original, and so far as I know, the only other record is from the North Pacific, off Japan, 191 fathoms. The species is evidently related to *R. aduncus*, Brady.

150. **Reophax aduncus**, Brady (SG 107).

Four stations: WS 383, 403, 471, 474.

Always very rare. The best specimens were found at Sts. WS 403 and 471. All the records are from deep water between 2085 and 3762 m.

151. **Reophax cushmani**, Heron-Allen and Earland (F 88).

Four stations: 177, 363; WS 201, 203.

A few very good specimens from 329 m. at St. 363 in the South Sandwich Islands, built of black volcanic scoriae. Small specimens are more frequent at St. WS 201 in the Scotia Sea at a depth of 4134 m. At the remaining stations only single specimens were found, that from St. WS 203 being of doubtful identity.

152. **Reophax sabulosus**, Brady (SG 106) (Plate IX, figs. 21, 22).

Three stations: WS 205, 512, 517.

A remarkably fine specimen about 6·0 mm. in length was found at St. WS 512 in the Bellingshausen Sea, depth 652 m. The characteristic thick outer layer is entirely composed of Radiolaria and diatoms, without apparent cement. A fragment consisting of the final chamber and neck found at St. WS 205 in the Scotia Sea, 4207 m., probably belongs to this species, as also fragments from St. WS 517 in the Bellingshausen Sea, 2770 m. In these instances the integument is sandy.

The occurrence of this large species, hitherto, with the exception of a single specimen in South Georgia, recorded only from the "Cold Area" of the Shetland-Faroe Channel, is particularly noteworthy.

Genus **Nodellum**, Rhumbler, 1913

153. **Nodellum membranaceum** (Brady) (Plate II, fig. 41).

Reophax membranacea, Brady, 1879, etc., RRC, 1879, p. 53, pl. iv, fig. 9; 1884, FC, p. 297, pl. xxxii, figs. 1–4.
Reophax membranaceus, Cushman, 1910, etc., FNP, 1910, p. 90, fig. 126.
Nodellum membranaceum, Rhumbler, 1911, etc., FPE, 1913, pp. 443, 473, text-fig. clxviii.
Reophax membranacea, Pearcey, 1914, SNA, p. 1006.

Five stations: 360; WS 204, 403, 471, 472.

Two specimens at each of the Sts. 360, WS 403, 471, 472 and a single specimen at St. WS 204. They are all chitinous and transparent, though some are of a deeper ferruginous tint than the others. The best specimens were found at Sts. WS 471 and 472. The depths range between 3264 and 3762 m., the stations being in the deep water of the Scotia Sea and Drake Strait. Pearcey records the species from 1775 fathoms in the Weddell Sea, and it is probably widely distributed in the deep water of all the seas, though specimens are always very rare.

It may be noted that the organism figured by Millett under the name *Reophax membranacea* (M. 1898, etc., FM, 1899, p. 255, pl. iv, fig. 14) is not Brady's species, but a variety of *Reophax scottii*, Chaster.

Rhumbler made Brady's species the genotype of *Nodellum*, and I think the separation is justifiable, as it has little in common with any other species of *Reophax*. In all the specimens I have seen the test is chitinous with, in some instances, the addition of sufficient ferruginous material to colour the chitin, but without the inclusion of any mineral particles. I doubt whether there are any true internal septa, except between the proloculus and the first chamber, the corrugations of the test giving a false impression of septation.

Genus Hormosina, Brady, 1879

154. **Hormosina globulifera**, Brady (F 89) (SG 108).

Eight stations: 362, 365, 369; WS 199, 468, 471, 472, 474.

Rare or very rare everywhere, the best station being St. 369 in 1767 m., where one exceptionally large specimen 5·0 mm. in length, and several smaller, were obtained. At most of the stations only one or two individuals were seen, mostly megalospheric. Good microspheric specimens at St. WS 472.

155. **Hormosina ovicula**, Brady (Plate III, fig. 1).

Hormosina ovicula, Brady, 1879, etc., RRC, 1879, p. 61, pl. iv, fig. 6; 1884, FC, p. 327, pl. xxxix, figs. 7–9.
Hormosina ovicula, Goës, 1894, ASF, p. 29, pl. vi, figs. 220–1; 1896, DOA, p. 34, pl. iv, figs. 1–2 (only, not fig. 3).
Hormosina ovicula, Cushman, 1910, etc., FNP, 1910, p. 95, fig. 138; 1918, etc., FAO, 1920, p. 28, pl. vi, fig. 2.
Hormosina ovicula, Wiesner, 1931, FDSE, p. 92, pl. xi, figs. 125–6.

Twenty-seven stations: 170, 175, 177, 181, 182, 362, 363, 365, 369, 373; WS 205, 388, 403, 482, 483, 489, 494B, 496, 506, 507A, 507B, 509–12, 514, 515.

Most of the records depend on fragments consisting of a single chamber only, as the long neck between the chambers is very fragile. Such fragments were common at Sts. WS 496 and 515, where specimens with three chambers were also found; frequent at Sts. 170, 177, 363, WS 510 and 514; rare at the remaining stations. The best specimens were found at Sts. 181 (four chambers) and 182 (five chambers, nearly 7·0 mm. long). There is considerable variety in the shape of the chambers, which are nearly always more slender than in Brady's figures, and sometimes very elongate. The range of depth is from 50 to 4207 m., but it is most frequent in comparatively shallow water.

156. **Hormosina ovicula var. gracilis** (Earland) (SG 105) (Plate III, fig. 2).

? *Rheophax distans*, Fauré-Fremiet, 1913–14, FMAF, 1913, p. 260, fig. 1; 1914, p. 2, pl. O, fig. 2.
Reophax distans var. *gracilis*, Earland, 1933, SG, p. 76, pl. ii, fig. 21.

Thirty stations: 169, 177, 181, 194, 360, 362, 383, 385; WS 199, 203–5, 377, 383, 385, 386, 395, 468, 471, 472, 474, 479, 482, 488, 494A, 496, 503, 507B, 515, 516.

Comparison with the numerous specimens of *H. ovicula*, found in the Antarctic material, has convinced me that the little organism figured in the South Georgia report under the name *Reophax distans* var. *gracilis* is a *Hormosina*, and closely related to *H. ovicula*. There is indeed no apparent distinction except in their comparative sizes, but there must be some zoological difference as *H. ovicula* was not found at all in South Georgia. In the Antarctic they frequently, but not always, occur at the same station, but even when they are found together there are no specimens intermediate in size between the two.

H. ovicula var. *gracilis* is common at St. WS 515, and frequent at Sts. 177 and 360, rare or very rare elsewhere. As in South Georgia, fragments of more than a single chamber are of rare occurrence, but two chambered specimens were found at Sts. 177, 360, 362, WS 199, 385 and 507B, and a single specimen with three chambers at St. WS 515. This last specimen is about 0·90 mm. long, and the chambers are less elongate than usual.

157. **Hormosina lapidigera**, Rhumbler (Plate IX, fig. 20).

Hormosina lapidigera, Rhumbler nov. spec., in Wiesner, 1931, FDSE, p. 92, pl. x, figs. 122–4.

One station: WS 502.

A single specimen about 4·0 mm. in length from 4224 m. in the Bellingshausen Sea appears to be referable to Rhumbler's species. It has a large *Cyclammina cancellata* built into the test in addition to the usual mineral fragments. The type was recorded from the Indo-Antarctic basin (65° 15′ S, 80° 19′ E) in 3400 m.

Genus **Haplophragmoides**, Cushman, 1910

158. **Haplophragmoides canariensis** (d'Orbigny) (F 90) (SG 109) (Plate III, fig. 10).

Seventy-two stations: 162–4, 167, 170, 175, 177, 180–2, 186, 187, 190, 194–6, 200, 202–4, 206, 209, 360, 363, 366, 369, 377; 62° 57′ S, 62° 20′ 30″ W; 64° 56′ S, 64° 43′ W; Port Lockroy; WS 201, 203, 204, 382–7, 389, 391–4, 400, 468, 469, 474–6, 480–8, 490, 493, 494A, 494B, 496–8, 507B, 509, 512, 514, 515, 517.

Almost universally distributed, occurring in each of the areas, and at all depths down to 4517 m. at St. WS 400 in the Drake Strait. As usual, it reaches its maximum development both in size and numbers at moderate depths, the specimens from stations below 1000 m. being small and sometimes pauperate. It is common and often very large at Sts. 363 and 366 in the South Sandwich Islands, also at Sts. 170, 177, 181, 190, 195 and WS 482 which are in the South Orkneys, South Shetlands and Palmer Archipelago. All these stations, except St. 177 (1080 m.), are in shallow water under 350 m. At most of the deep-water stations the species is represented by few and small individuals, and the same comment applies particularly to the stations in the Bellingshausen Sea, irrespective of their depth. Both involute and evolute specimens occur, the former condition being normal. Sometimes the two forms occur together as at Sts. 195 and WS 482, but at Sts. 163 and 164 the evolute form predominates. Abnormal individuals are not infrequent.

At St. 181 in the Palmer Archipelago, depth 160–335 m., where the species is common, a very remarkable object was found. It consists of a fragment of apparently chitinous tissue, of unknown origin, in the folds of which, more or less imbedded in mud, are numerous young and immature specimens of *H. canariensis* (Pl. III, fig. 10). No less than fifteen can be counted. It is evidently not a case of encystment, for the individuals are in various stages of growth. A possible explanation of their occurrence in such surroundings is that they are the remains of a brood of young individuals, formed by the breaking up of the protoplasm of a microspheric parent which had settled on the fragment of membrane. In the case of a few of the specimens which are favourably placed it can be stated that they are megalospheric, and this is probably the case with all of them.

159. **Haplophragmoides canariensis** var. **variabilis** (Heron-Allen and Earland) (F 91).

Six stations: 170, 175, 177, 190; WS 482, 517.

This wild-growing variety is common at St. 175 and frequent at St. WS 482, both in the Bransfield Strait, depths 200 and 100 m. respectively, but rare or very rare elsewhere.

160. **Haplophragmoides crassimargo** (Norman) (F 92) (SG 110).

Five stations: 180, 383; WS 495, 516, 517.

Frequent at Sts. WS 495 and 517 in the Bellingshausen Sea in depths of 2552–2770 m.; very rare elsewhere. All the specimens are rough externally, except the single specimen noted at St. 180, which is also the only shallow water record (160 m.).

161. **Haplophragmoides sphaeriloculus**, Cushman (F 93) (SG 111).

Twenty-four stations: 177, 180, 181, 360, 373, 377, 382, 383; WS 199, 203, 403, 468, 471, 472, 474, 479, 494A, 502, 509, 516, 517, 552, 553, 555.

With very few exceptions the records of this species are confined to the deep water of the Weddell, Scotia and Bellingshausen Seas, and the specimens are usually small and very rare, seldom more than one at a station. Good specimens, however, are frequent at St. 360 in the Scotia Sea (3264 m.), also in 170 m. at Sts. 180, 181. Both of these shallow-water stations are in the Palmer Archipelago. Large and typical specimens were common at St. WS 517 in the Bellingshausen Sea at a depth of 2770 m., which were probably megalospheric, as spherical primordials of large diameter (0·012 mm.) were found associated with them.

162. **Haplophragmoides trullissatus** (Brady) (Plate III, fig. 9).

Trochammina trullissata, Brady, 1884, FC, p. 342, pl. xl, figs. 14–15 (only).
Haplophragmoides trullissata, Cushman, 1918, etc., FAO, 1920, p. 43, pl. ix, fig. 5.

Thirty-five stations: 177, 180, 181, 194, 363, 382–4, 386; WS 199, 203, 205, 400, 468, 471, 472, 474, 483, 488, 494A, 496–8, 503, 506, 507A, 507B, 509–11, 514–17, 555.

Generally distributed in all the areas and irrespective of depth, the records ranging between 160 and 4773 m. Curiously enough the species is common and very well developed at the two shallowest stations, 180 and 181, in the Palmer Archipelago, depth 160 m. It is frequent at Sts. 177 in the Bransfield Strait (1080 m.), WS 474 in the Scotia Sea (2813 m.), and WS 510 in the Bellingshausen Sea (505 m.). At the remaining stations it is rare or very rare, often represented by single specimens. The colour varies greatly between the normal orange and a dark grey, due to the incorporation of black volcanic sand. At many stations, notably Sts. WS 471 and 474, the typical evolute form occurs in company with an involute form in which only the final convolution is exposed. At St. 181 an abnormal specimen was observed, in which each successive chamber was narrower at its commencement than its predecessor, thus giving a distinctly serrate appearance to the peripheral edge. With these exceptions all the specimens were very true to type.

163. **Haplophragmoides scitulus** (Brady) (F 94) (SG 112) (Plate X, figs. 20, 21).

Fifteen stations: 170, 175, 180, 181, 196, 199, 363; WS 386, 468, 472, 479, 484, 494A, 514, 517.

The typical form with slightly evolute test having an excavate umbilicus on each face is widely distributed in all areas, and at all depths down to 4344 m. at St. WS 468. It is generally rare or very rare, but is not uncommon at Sts. 180, 181 and WS 479. The "oval variety" referred to and figured in the South Georgia report (p. 78, pl. iii, figs. 11–12) generally occurs with it, but is much more widely distributed. Owing to differences in its internal structure, the "oval variety" has been raised to generic rank under the name *Recurvoides contortus* (No. 169).

164. **Haplophragmoides quadratus**, sp.n. (Plate III, figs. 7, 8).

One station: WS 515.

Test compressed, square in outline with rounded-off corners, exhibiting only four completely involute chambers on each flattened face. Peripheral edge round but entire; sutures distinct, very slightly depressed. Aperture obscure, probably a fine slit on inner edge of terminal chamber, but obstructed with mud.

Examined as a transparent object, an inner convolution of small chambers, similarly arranged, becomes visible.

Constructed very neatly of fine sand and cement; wall thin but firm and smooth, not polished.

Diameter 0·30 mm.; thickness 0·16 mm.

Only a single specimen was found in 512 m. in the Bellingshausen Sea, but it is so distinctive in structure that I have given it a name. It is isomorphic with the compressed variety of *Pullenia sphaeroides* which occurs at the same and other stations, but is quadrate instead of circular in form. It bears also a certain resemblance to the four-chambered specimens of *Trochammina bradyi* referred to under that species (No. 196), but the test is differently constructed of sand instead of cement, and the two forms can hardly be confused together.

165. **Haplophragmoides nitidus** (Goës) (Plate III, figs. 3–6).

Haplophragmium latidorsatum (*pars*) Goës (*non* Bornemann), 1894, ASF, p. 21, pl. v, figs. 121–3.
Haplophragmium nitidum, Goës, 1896, DOA, p. 30, pl. iii, figs. 8–9.
Haplophragmoides nitidum, Cushman, 1918, etc., FAO, 1920, p. 44.

Eight stations: 365, 369; WS 205, 403, 472, 502, 503, 552.

This is a fairly distinctive species with a very wide distribution. Goës originally (1894) gave it no name, but under his description of *H. latidorsatum* (= *H. subglobosus*) describes it as "var. minus, saepe umbilicatum, nitidum, suturis impressis, segmentis turgidis visibilibus numero 4". The specimens figured were from the Skagerack, depth, 180 m. In 1896 he separated it as a species and described it as "smooth and glossy usually narrow umbilicated; number of segments 4; colour brown, reddish or yellow;

always only half the size of the type" (= *H. subglobosus*). These specimens were from the Caribbean Sea 530–1830 fathoms.

Cushman gives a fuller description on the same lines. He says the species is not found on the American coast north of South Carolina. On the European shores of the Atlantic I have found it in many Goldseeker dredgings made in the deeper parts of the North Sea.

The Discovery specimens are all from deep water, 1536–4845 m., and the stations are spread over the Weddell, Scotia and Bellingshausen Seas. It is always rare, but perfectly typical four-chambered specimens occurred at Sts. WS 403, 502 and 552. They are usually dark grey in colour. A variety, somewhat larger and constructed of coarse sand with rough exterior, was found with the type at Sts. WS 472 and 502. It agrees in other respects with the type. The number of chambers visible in the last convolution is usually four, but specimens with five chambers have been noted both in the typical smooth form and in the rough variety. The test averages about 0·45 mm. in greatest diameter but ranges up to double this size.

166. **Haplophragmoides subglobosus** (G. O. Sars) (F 95) (SG 113).

Thirty-nine stations: 362, 363, 365, 369, 373, 377, 382–6; 62° 57′ S, 60° 20′ 30″ W; WS 199, 201, 203, 204, 377, 400, 403, 468, 469, 471, 472, 474, 479, 485, 495, 498, 502, 503, 505, 506, 507 A, 512, 516, 517, 552, 553, 555.

Occurs in the deeper areas of the Bellingshausen, Scotia and Weddell Seas where it is often common, even very common at Sts. WS 474, 479, 495 and 502. But with the noteworthy exception of the gatherings made in the Palmer Archipelago where it was not recorded at all, it is also found in comparatively shallow water, though usually very rare, except at St. 363 in the South Sandwich Islands, 329 m., where it was frequent, the specimens being constructed of larger sand grains than usual, and rough externally. Similar coarsely built specimens were noted at a few other stations, often in company with the normally smooth form. In very large individuals the typical single aperture becomes a narrow slit, often separated into a series of small apertures extending along the inner marginal edge of the terminal chamber. Cushman has separated such specimens generically under the name *Cribrostomoides bradyi* (C. 1910, etc., FNP, 1910, p. 108, fig. 167), but I am unable to see any valid reason for their separation, even varietally, from the type. Every stage in the development of the aperture can be traced in gatherings where the species is abundant, as in the *Haplophragmium* ooze of the Cold Area of the Faroe Channel. Specimens answering to Cushman's figure were noted at Sts. WS 495, 502, and doubtless occurred elsewhere.

167. **Haplophragmoides glomeratus** (Brady) (SG 114).

Sixty-two stations: 167, 170, 175, 177, 180, 181, 192, 194–6, 202–4, 206, 209, 360, 377, 383, 384; 62° 57′ S, 60° 20′ 30″ W; WS 199, 203–5, 377, 383, 387, 389, 393, 395, 396, 400, 468, 469, 471, 472, 474, 480, 482–9, 493, 494 A, 496, 498, 502, 503, 506, 507 A, 507 B, 509, 512–16, 552.

Occurs in all the areas, and at all depths between 100 and 4845 m. It is common but small at St. 180 in the Palmer Archipelago, depth 160 m.; common and large at St. WS 472 in the deep water of the Scotia Sea, 3580 m. At Sts. 175, 177, 194, WS 395, 471, 486, 502 and 552 it is frequent, and as the depths at these stations range between 200 and 4845 m., depth would appear to have little influence on this species. Nevertheless, it may be taken as a general rule that specimens from the deeper stations are larger and more coarsely constructed than those from shallower waters. At the remaining stations it is rare, frequently represented by single specimens. Two distinct forms occur, often in company, one being long and narrow, the other broad and shorter. They probably represent the microspheric and megalospheric forms, but it was not possible to verify the internal structure in the time available.

168. **Haplophragmoides rotulatus** (Brady) (SG 115).

Nineteen stations: 202, 362, 383, 386; WS 199, 204, 377, 399, 468, 469, 471, 472, 474, 495, 502, 503, 552, 553, 555.

Occurs in the deep water of the Weddell, Scotia and Bellingshausen Seas, and in the Drake Strait, but is never common, the only stations at which it was found with any frequency being WS 495 and 503 in the Bellingshausen Sea. It is essentially a deep-water species; with the exception of Sts. 202 (909 m.) and WS 399 (738 m.), all the records lie between 2552 and 5029 m.

Genus **Recurvoides**, gen.n.

Test free, arenaceous, composed of several convolutions, each containing many chambers. The convolutions are planospiral and partially embracing but arranged in two series, the axis of winding of the second series being approximately at right angles to that of the first or earlier series. The second series therefore envelops the first, but leaves the peripheral edge of the final convolution of the first series visible on one of the faces as a raised line of chambers, extending across the umbilical portion of the adult test. The umbilical portion of the opposite face is more depressed. Composed of sand grains of varying sizes with a considerable amount of ferruginous cement. Aperture small, on the inner edge of the final chamber, sometimes having protruding lips.

Recurvoides has many points of resemblance to *Haplophragmoides*, Cushman, but differs from that genus, which is planospiral throughout growth, in its variable axis. It thus bears much the same relationship to *Haplophragmoides* as *Glomospira* to *Ammodiscus*. *Trochamminoides*, Cushman, 1910, of which the genotype is *Trochammina proteus*, Karrer, has sometimes a varying axis but is quite distinctive in its irregular chambering and construction. The genotype is *Recurvoides contortus*, sp.n., which is based on the specimens recorded and figured in the South Georgia report under the name "*Haplophragmoides scitulus*, Brady, oval variety" (SG 112 and pl. iii, figs. 11, 12). Their real structure did not become apparent until sections were made. Apart from their oval contour due to the change of axis, which becomes less apparent after more than one convolution of the second series has become completed, specimens of *Recurvoides contortus* and *Haplophragmoides scitulus* are externally in close agreement, and the two species often occur together. Horizontal sections of the two forms are quite different. That the two organisms are not zoologically related is proved by the fact that both megalospheric and microspheric specimens of each have been found.

The two species have been confused by authors ever since *H. scitulus* was created by Brady in 1881, although Brady's figures are correct for his species. An examination of the records will be necessary to separate the forms. At present I can only state that *Recurvoides* is very widely distributed. It was included in several of the Terra Nova records of *Haplophragmium scitulum* (Sts. 6, 10, 13, 22 at least—H.-A. and E. 1922, TN, p. 99), thus including both the New Zealand and Antarctic areas.

The specimen figured by Wiesner from Kaiser Wilhelm's Land under the name *H. scitulus*, Brady, is unquestionably *Recurvoides contortus*, as it shows the inequilateral coiling and a convex umbilical area. He mentions that his specimens, which were abundant, were built of coarser sand grains than Brady's type. This is frequently the case, although *R. contortus* in the Discovery material shows great variation in the material used, sometimes employing coarse sand grains, and at other times fine sand and mud.

At an earlier date Flint had confused the two forms (F. 1899, RFA, pl. xx, fig. 2), for the section shown in his photograph of *Haplophragmium scitulus* is clearly *Recurvoides contortus*, as also is at least one of his other figures. He records *Haplophragmium scitulus* from the West Indies and the west coast of Patagonia, but there is no evidence as to the locality from which his figured specimens came.

The two species occur together in various dredgings from deep water off the British Isles, and have been recorded as *H. scitulus*. The species described by Brady as *Haplophragmium turbinatum* (B. 1884, FC, p. 312, pl. xxxv, fig. 9) has been placed by various authors in *Haplophragmium*, *Haplophragmoides* and *Trochammina*. It should be known in future as *Recurvoides turbinatus* (Brady). Brady's original figure clearly shows a change in the axis of coiling, and an examination of a series of specimens in different stages of growth from the type station "Challenger 346" has proved its structure to be that of *Recurvoides*. Possibly an examination of some other types of *Haplophragmoides* may lead to the transfer of further species to the new genus.

The small specimens recorded in the South Georgia report (SG 139) under the name *Trochammina turbinata*, Brady, do not possess a variable axis, but are true *Trochamminae*. They are described subsequently as *Trochammina inconspicua*, sp.n. (see No. 199 *post*), and the South Georgia report should be amended.

169. **Recurvoides contortus**, sp.n. (Plate X, figs. 7–19).

Haplophragmium scitulum (*pars*), Flint, 1899, RFA, p. 276, pl. xx, fig. 2.
Haplophragmoides scitula, Wiesner, 1931, FDSE, p. 96, pl. xii, fig. 141.
Haplophragmoides scitulum, "oval variety", Earland, 1933, SG, No. 112, pl. iii, figs. 11–12.

Sixty-five stations: 170, 171, 175, 177, 180–2, 194, 196–8, 203, 204, 360, 362, 363, 365, 369, 377, 383, 384; 62° 57′ S, 60° 20′ 30″ W; WS 199, 201, 204, 383–7, 391, 393, 394, 403, 469, 471, 472, 474–6, 479, 480, 482–6, 494A, 494B, 495, 497, 498, 502, 505, 506, 507B, 509, 510, 512–17, 555.

The general characters of the species are those of the genus. The test varies greatly in appearance at different stages of growth. The young shell resembles a *Trochammina*, convex on one face and with a depressed umbilical area on the other. The adult shell is nearly circular and closely resembles *Haplophragmoides scitulus*, from which it may be readily distinguished by the appearance of the umbilical recesses. In *Haplophragmoides scitulus* the growth being planospiral and evolute, the umbilici are well-marked depressions of equal depth on either face. In *Recurvoides contortus*, on the other hand, the umbilicus on one face is often deeply depressed, while on the other the umbilical space is either flat or slightly convex. The convexity marks the peripheral edge of the last convolution before the change in the axis of coiling. Horizontal sections show that the early convolutions are coiled round an axis set at an angle of approximately 90° to the plane of subsequent convolutions. In the megalospheric form a large proloculus is followed by a single convolution of about seven chambers; the axis of coiling then changes and a further 1–2 convolutions in the new plane completes the test. In the microspheric form there are apparently two or more convolutions before the plane of coiling changes.

R. contortus is one of the most widely distributed species, being found in all the areas between 50–4224 m. It favours moderate depths and is often very common, notably at Sts. 170, 175, 177, 196, 363; WS 383, 386, 483 and 494A. Large specimens attain a diameter of about 1·0 mm.

Genus **Ammobaculites**, Cushman, 1910

170. **Ammobaculites agglutinans** (d'Orbigny) (F 96) (SG 116).

Seventeen stations: 169, 177, 196, 369, 386; WS 403, 469, 471, 472, 494A, 495, 502, 503, 516, 517, 552, 553.

Generally distributed over the entire area but usually rare or very rare. It is, however, frequent and typical at Sts. WS 471, 516 and 552. The specimens are of the North Atlantic form figured by Brady (B. 1884, FC, pl. xxxii, figs. 20, 24), though the uniserial chambers are rarely developed to the extent of his fig. 20. There is the usual wide range of variation in the construction of the test, which is often very rough. At Sts. 177 and 369 dark volcanic angular sand grains give a very unfinished appearance, and immature specimens of this construction are not easily separated from *Haplophragmoides rotulatus*. The depths range between 720 m. at St. 196, where only two small specimens were found, and 5029 m. at St. WS 553, where very good examples were obtained.

171. **Ammobaculites agglutinans var. filiformis, var.n.** (SG 116) (Plate III, figs. 11–13).

Haplophragmium agglutinans (*pars*), Brady, 1884, FC, pl. xxxii, figs. 22–23.
Haplophragmium agglutinans, Sidebottom, 1918, FECA, p. 14, pl. ii, fig. 10.
Haplophragmium agglutinans, Heron-Allen and Earland, 1922, TN, p. 97, pl. iii, fig. 15.
Ammobaculites agglutinans (*pars*), Earland, 1933, SG, p. 79, pl. ii, fig. 22.

Twenty-five stations: 177, 360, 362, 373, 383, 386; WS 199, 203–5, 400, 469, 471, 472, 474, 479, 498, 502, 503, 506, 513, 515–17, 552.

The variety agrees with the type species in practically all respects except its minute size, and was described and figured, under the specific name only, in the South Georgia report (SG 116). But its occurrence in company with the typical species at ten stations, without specimens of intermediate size connecting the two forms, and still more its occurrence at seven other stations where the type species was not found at all, have decided me to give it a varietal name. It is frequent at Sts. 360, WS 471, 472, 516, but rare elsewhere. Most of the records are in deep water.

There is even more range of variation in construction than occurs in the type species. Most of the specimens are roughly constructed and the rectilinear series is well developed, ranging between four and ten chambers. Usually the rougher the construction is, the shorter the test. An abnormally long specimen with fifteen chambers in the uniserial portion, found at St. WS 472, is very smoothly built, with an excess of cement. Typical short and roughly constructed specimens were found at the same station. Similar organisms were found in the Ross Sea by the Terra Nova Expedition, and figured as "pauperate" specimens of *Haplophragmoides agglutinans*, so the variety would appear to be constant in the Antarctic.

172. **Ammobaculites americanus**, Cushman (F 97) (SG 117).

Eight stations: 385; WS 469, 474, 495, 505, 515, 516, 555.

Curiously rare as compared with its abundance in the South Georgia area. Even the few specimens found were small and pauperate; the best were at Sts. WS 469 and 495.

173. **Ammobaculites tenuimargo** (Brady) (SG 120).

Two stations: 360; WS 403.

A single small specimen at each of these deep-water stations.

174. **Ammobaculites foliaceus** (Brady) (SG 121).

Thirty-one stations: 177, 360, 365, 383, 384, 386, 387; WS 199, 201, 204, 386, 395, 400, 471, 473, 474, 483, 484, 494A, 496, 497, 502, 506, 507A, 507B, 511, 512, 515–17, 555.

Generally distributed over the entire area but never present in any numbers, and at most stations rare or very rare. The stations show a wide range in depth between 512 m. at St. WS 515 and 4773 m. at St. 386. Depth does not appear to influence structure much, although as a rule specimens from stations under 1000 m. are thinner and more neatly constructed of fine material than those from deeper water, which are often of rougher construction, sometimes incorporating a few larger sand grains which spoil the symmetry of the tests. Particularly neat and thin specimens were found at the series of stations WS 502–507B. The species was most frequent at Sts. WS 199 and 516, both in deep water. At many of the deeper stations, especially Sts. WS 199, 386, 473, 502, 517, 555, the spiral portion of the test shows a tendency to become inequilateral, one face being more or less concave and the other convex. When this inequilateral growth extends over the whole test it forms a very striking variety which seems deserving of varietal distinction.

175. **Ammobaculites foliaceus** var. **recurva**, var.n. (Plate III, figs. 14–17).

Ten stations: 360, 362; WS 471, 472, 502, 503, 505, 517, 552, 553.

The type species is quite flat; the variety differs only in the fact that the outer edge is incurved towards the face of the test. As noted under the description of *A. foliaceus*, some specimens from the deeper stations exhibited an inequilateral structure of the early spiral portion, becoming normally flat in the extended stage. In well-marked specimens of the variety *recurva* this curling over of the outer edge is continuous throughout growth, the fully developed test presenting quite a distinctive appearance, being deeply concave on one face and convex on the other. The variety appears to be confined to the deeper stations, between 1500 m. at St. WS 505 and 5029 m. at St. WS 553. The best specimens were found at St. 362 in the Scotia Sea, depth 3370 m. At this station and several others the type species was not recorded, but too much importance should not be attributed to this having regard to the small samples of material available for examination. The records are spread over a wide area in the Weddell, Scotia and Bellingshausen Seas.

Length up to 0·60 mm. or more; breadth 0·40 mm.; thickness about 0·15 mm.

Genus **Ammomarginulina**, Wiesner, 1931

176. **Ammomarginulina ensis**, Wiesner (SG 122).

Twenty-one stations: 360, 382–6; WS 199, 203–5, 400, 403, 468, 471, 472, 474, 495, 502, 503, 516, 517.

Generally distributed over the entire area, but confined to deep water between 2582 and 4773 m. It is one of the most characteristic Antarctic species and often occurs in considerable numbers, notably at Sts. WS 502 and 503 in the far south-west of the Bellingshausen Sea, where it is common in over 4000 m. It occurs frequently also at Sts. 382, 383, WS 471 and 472 which are in the Scotia Sea to the north of the South Shetlands. There is considerable range of variation, two forms occurring often in company, one being broad and flat and microspheric; the other, narrow and with the extended portion almost cylindrical, is the microspheric form. The axis of growth is often more or less curved, so that the extended chambers are not in the same plane as the early spiral portion of the test.

Genus **Placopsilina**, d'Orbigny, 1850

177. **Placopsilina confusa**, Cushman (F 98) (SG 123).

Placopsilina cenomana, Brady (*pars*), 1884, FC, pl. xxxvi, figs. 2 and 3 (only).
Placopsilina confusa, Cushman, 1918, etc., FAO, 1920, p. 71, pl. xiv, fig. 6.
Placopsilina cenomana, Heron-Allen and Earland, 1932, F, p. 341, pl. vii, fig. 25.
Placopsilina cenomana, Earland, 1933, SG, p. 83.

Six stations: 384; WS 468, 469, 494A, 495, 505.

A few specimens only were recorded, but the species is probably fairly common when suitable material for attachment is available.

Since the Falkland and South Georgia reports were published Dr J. A. Cushman has been good enough to send me a specimen of his species *P. confusa*. It is unquestionably identical with the organism recorded in those reports, and with British specimens hitherto known as *P. cenomana*. Cushman regards it as distinct from the larger tropical organism. Except for its smaller size and propensity for deeper water, the size in my opinion being influenced by the depth, it appears to have no structural differences, and I doubt its zoological distinction. It is, however, sufficiently characteristic for separation taxonomically.

The "distinctive organism" referred to in the Falkland report is quite different, and is described in this report under the new generic name *Placopsilinella* (see No. 178).

Genus **Placopsilinella**, gen.n.

Test minute, sessile, chitinous with some admixture of ferruginous cement, consisting of an indeterminate number (up to 50 or more) of subglobular chambers in a single layer. Initial chambers apparently arranged in a loose spiral line of single chambers, subsequently developing into an irregularly curving line with at first two, then three or four chambers abreast. No external aperture or means of communication between the chambers can be traced. Colour deep orange-yellow.

178. **Placopsilinella aurantiaca**, sp.n. (Plate III, fig. 18).

Eight stations: 360, 384; WS 204, 403, 468, 469, 494A, 517.

Very rare at all stations.

The characters of the genus are a sufficient description of the genotype species, which is of rare occurrence and apparently confined to deep water. The stations are in the Scotia and Bellingshausen Seas, the Drake and Bransfield Straits, and the depths are between 2770 and 4344 m., except one station, WS 494A, which is in the comparatively shallow depth of 1035 m. This species is generally adherent to other Foraminifera, usually *Globigerina* or *Globorotalia*, and is then conspicuous by the bright orange colour of the chambers contrasting with the white test of its host. The chambers look like rows of tiny oranges. But it also occurs on sand grains or pebbles at Sts. 360, WS 468, 469 and 494A, and at St. 384 two small manganese nodules bore several colonies.

The initial spiral which is most evident in the specimen from St. WS 204 seems to mark an affinity with *Placopsilina*, from which it differs in the development of double or triple rows of chambers. I have not seen any case in which chambers have been superimposed.

Diameter of separate chambers up to 0·03 mm.

A colony may have a length up to 0·3 mm. and breadth 0·2 mm.

This interesting little form probably has a wide distribution in cold water, as I have specimens from the North Atlantic in 1782 fathoms (U.S.F.S. 'Albatross', St. 2569, 39° 26′ N, 68° 03′ W). The species is of more frequent occurrence than in the Antarctic, but the individual chambers are darker and more chitinous, perhaps rather smaller. I have also found a specimen at Challenger St. 5 (24° 20′ N, 24° 28′ W, 2740 fathoms).

Sub-family *TROCHAMMININAE*

Genus **Ammolagena**, Eimer and Fickert, 1899

179. **Ammolagena clavata** (Jones and Parker) (F 99) (SG 124).

Fifteen stations: 373, 383, 385, 387; WS 201, 203, 204, 468, 469, 471, 495, 502, 507A, 517, 555.

Generally distributed but never common, although this may be due largely to the absence at many stations of mineral fragments suitable for a sessile organism. At several stations the only specimens were sessile on other Foraminifera. It was frequent at St. WS 555, where a very large specimen was found attached to *Cyclammina cancellata*, and many very small specimens on sand grains. Frequent also at St. 383, rare or very rare at the remaining stations. Ferruginous specimens are infrequent, the usual colour being a silvery grey. This species has a very wide range in depth and is often common in comparatively shallow water. It is rather noteworthy therefore that only one record (St. WS 507A) is from 572 m., all the others being from depths between 2582 and 4344 m.

Genus **Tolypammina**, Rhumbler, 1895

180. **Tolypammina vagans** (Brady) (F 100) (SG 125).

Twenty-six stations: 161, 164, 170, 175, 177, 180–2, 190, 195, 377, 383, 384; WS 468, 469, 482, 494A, 494B, 497, 498, 505, 514, 516, 517, 523, 555.

The species is frequent or common wherever material suitable for the attachment of a sessile organism is abundant, notably at Sts. 177, 181, 182, 190, 384, WS 469, 482 494B. At other stations it is rare and the specimens are very small, in conformity with the size of their bases of attachment. The stations cover all ranges of depth. Wiesner (W. 1931, FDSE, p. 94) records three species from the Antarctic, *T. schaudinni*, Rhumbler, *T. frigida* (Cushman) and *T. hedrix*, n.sp., Rhumbler, but reports *T. vagans* only from extra-Antarctic stations. I regard his three forms as mere variations of the protean *T. vagans*, and have not separated them.

Genus **Ammodiscus**, Reuss, 1861

181. **Ammodiscus incertus** (d'Orbigny) (F 101) (SG 126).

Forty-three stations: 170, 171, 175, 177, 180, 181, 186, 190, 191, 194–6, 202, 203, 360, 363, 366, 383, 385; WS 201, 203, 205, 383, 393, 468, 469, 471, 472, 479, 480, 482, 485, 487, 488, 494A, 498, 502, 511, 512, 514, 516, 552, 555.

Almost universally distributed in the area, and at all depths between 100 and 4845 m. Most of the specimens are small, and vary considerably between very neatly coiled and typical shells and those showing a tendency to irregular coiling. These latter, as in South Georgia, pass imperceptibly into *Glomospira gordialis*. The typical form is common but small at St. 177, larger but rare at Sts. WS 468, 494A. At most other stations it is rare or very rare. All the specimens seen were microspheric except for two megalospheric specimens (= *Ammodiscus tenuis*, Brady, 1884, FC, p. 332, pl. xxxviii, figs. 4–6) found at St. WS 555 in 3850 m., where the microspheric form was also observed, and a single megalospheric specimen at St. WS 469 in 3959 m. The microspheric form was not recorded at this station. These data indicate that, in this species at least, the megalospheric form is extremely rare and can play only a secondary part in the propagation of the species.

Genus **Ammodiscoides**, Cushman, 1909

182. **Ammodiscoides turbinatus**, Cushman (Plate III, fig. 19).

Ammodiscoides turbinatus, Cushman, 1909, A, p. 424, pl. xxxiii, figs. 1–6.
Ammodiscoides turbinatus, Cushman, 1918, etc., FAO, 1918, p. 98, pl. xxvi, figs. 3–6, pl. xxxvii, figs. 1–6.

One station: 175.

A single specimen from 200 m. in the Bransfield Strait, South Shetlands, is probably referable to Cushman's genus, which he separated from *Ammodiscus* because the early convolutions are in the form of a hollow cone, with planospiral convolutions following. The distinction appears to be very slight, but the author says that his specimens, which were from the Gulf of Mexico and the Brazilian coast, are not usually associated with *Ammodiscus incertus*, from which it differs only in the early cone-shaped whorls. He reports that only the microspheric form has been found.

The Discovery specimen is immature; starting with a proloculus more than double the width of the succeeding coil, it has six coils in the cone, which is slightly tilted to one side of the vertical axis; the cone is followed by three plane convolutions. There is a very gradual increase in the diameter of the successive convolutions throughout. Maximum diameter 0·25 mm.

Genus **Glomospira**, Rzehak, 1885

183. **Glomospira gordialis** (Jones and Parker) (F 102) (SG 127).

Thirty-eight stations: 167, 170, 171, 175, 177, 180, 181, 190, 192, 197, 203, 204, 360, 363, 366, 369, 373, 383, 385; 62° 57′ S, 60° 20′ 30″ W; WS 203, 383, 384, 386, 387, 389, 469, 471, 479, 481–3, 487, 490, 495, 516, 552, 555.

Almost universally distributed and found at all depths down to 4845 m. It is common at Sts. 177 and WS 482, frequent at Sts. 175, 181, 190, 360, 383 and WS 516, rare elsewhere. Three different varieties occur, usually at different stations but occasionally together. The most widely distributed is a nearly flat form, only separable from irregular specimens of *Ammodiscus incertus* by the extreme irregularity of the convolutions; in the next form the tube is coiled in a tangled mass without any definite plan. It is much less frequent but was noted at Sts. 175, 177, 181, 190, 363 and WS 482. These two forms have an unpolished surface owing to the lack of cement. The third form may resemble either of the others in shape, but is distinguished by the use of an excessive quantity of ferruginous cement which gives a polished exterior to the brown test. It appears to be confined to a few of the deeper stations, most of the records being below 2000 m., although there are single records from 262 m. (St. WS 490) and 843 m. (St. 204). It was frequent at St. 383 in 3744 m., and at St. WS 516 in 2611 m. Sessile specimens of the first form were recorded at Sts. 190 and WS 482.

184. **Glomospira charoides** (Jones and Parker) (F 103) (SG 128).

Twenty-five stations: 175, 177, 360, 362, 373, 383, 384; WS 203–5, 468, 469, 471, 472, 474, 483, 487, 494A, 495, 502, 503, 515–17, 555.

Widely distributed, generally in deep water, eighteen of the records being from over 2000 m. But it is also found in shallower water, and the best and largest specimens were from Sts. 175 (200 m.), WS 487 (790 m.) and WS 494A (1035 m.); only a single specimen at each of these stations. It is frequent but rather small at Sts. 360 (3264 m.), WS 503 (4072 m.) and WS 555 (3850 m.), rare or very rare elsewhere.

Genus **Turritellella**, Rhumbler, 1903

185. **Turritellella shoneana** (Siddall) (SG 129).

Five stations: 170, 190; WS 481, 482, 494A.

Two good specimens at St. 170, but only single specimens at the other stations. The depths range between 50 and 1035 m. All the stations are in a line running south-west from the South Orkneys through the Bransfield Strait to the most southerly station, St. 190, which is to the west of the Palmer Archipelago.

186. **Turritellella laevigata**, Earland (SG 130).

Five stations: 175, 363; WS 468, 481, 482.

Very rare at St. 363 in 329 m. off Zavodovski Island in the South Sandwich Islands. Rare at Sts. 175 and WS 482, which are in the Bransfield Strait between the South Shetlands and Graham Land, in depths of 200 and 100 m. respectively. A single specimen from 543 m. at St. WS 481, also in the Bransfield Strait, and another from St. WS 468 which is in the Drake Strait, almost in the latitude of Cape Horn and outside the Antarctic convergence. This last record is of particular interest on account of the great depth at the station, viz. 4344 m. All the specimens are good and identical with the South Georgia types.

Genus **Ammoflintina**, gen.n.

Test free, arenaceous, approximately triangular in outline, planospiral and bilaterally compressed. Consisting of a proloculus, part of which in the megalospheric form at least is visible on both faces of the test, and around which the chambers are coiled, three chambers forming a convolution. Number of convolutions one or two. The chambers are V-shaped in transverse section, broad and embracing, narrowing a little towards the oral end. The aperture is large and simple, without lip or tooth. Peripheral edge subacute. The wall of the test is thin and fragile, composed of fine mineral grains with much cement; colour pale brown.

187. **Ammoflintina trihedra**, sp.n. (Plate III, figs. 20–23).

Three stations: 384, 385; WS 204.

The description of the genus must suffice for the species, which is extremely rare; three specimens were found at St. WS 204, one at St. 384 and two at St. 385. All stations are in the deep water of the Scotia Sea and Drake Strait, depths 3328 to 3713 m. Most of the specimens are damaged. As a rule there is only a single convolution of three chambers, but some of the specimens have remains of a second convolution which is less regularly disposed, the test losing its flat planospiral form and becoming polyhedral and irregular. The sutures are distinct and slightly depressed. Viewed as a transparent object the proloculus is large and circular, occupying nearly half the diameter of a test with one convolution. The septa are rudimentary; though well-marked externally, they are found to be mere projections from the inner wall into the tube, which loses very little in diameter at the point of constriction. The plan of growth is reminiscent of *Flintina* in the Miliolidae, hence the name I give to the genus.

Maximum diameter up to 0·40 m.

More material must be studied before the affinities and systematic position of *Ammoflintina* can be settled with certainty. My specimens are apparently all megalospheric, though the proloculus varies in size. From the nature of the test and the rudimentary septation I place the genus among the Ammodiscinae, regarding it as a transition form between the simple tube of *Ammodiscus* and the fully septate Trochammininae. Its nearest ally appears to be *Lituotuba*, Rhumbler, 1895, based on *Trochammina lituiformis*, Brady.

Genus Trochammina, Parker and Jones, 1860

188. **Trochammina squamata**, Jones and Parker (F 104) (SG 131).

Twenty-seven stations: 177, 195, 360, 362, 373, 382–5; WS 199, 203, 204, 400, 403, 468, 469, 471, 472, 474, 476, 495, 502, 503, 516, 517, 552, 555.

Almost confined to the deepest water stations, eighteen of the records being from over 3000 m., and only three under 2000 m. Specimens are usually rather small but were very large and typical at Sts. WS 203, 469, 472 and 517, where they were frequent, and at St. WS 468, where the species was rare. A small sessile individual was found at St. WS 199 where free small specimens were frequent. Small specimens were common at St. WS 471.

189. **Trochammina rotaliformis**, J. Wright, MS. (F 105) (SG 132).

Twenty-one stations: 170, 175, 180, 181, 187, 191, 195–7, 200, 204, 206, 363, 366; Port Lockroy; WS 382, 389, 476, 482, 485, 494A.

Common in the anchor mud from Port Lockroy, and frequent at Sts. 175, 180, 206, 363, WS 482 and 485; rare or very rare elsewhere. Nearly all the records are in shallow water, but there are a few deep records extending down to 1974 m. at St. 197. Nearly all the specimens are very dark in colour, resembling *T. ochracea*, from which in fact they are only separable by the highly convex dorsal surface.

190. **Trochammina ochracea** (Williamson) (F 107) (SG 133).

Fifty stations: 169–71, 175, 177, 180, 181, 185–7, 190–2, 194, 196, 199, 200–4, 206, 209, 363; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; Port Lockroy; WS 386, 387, 391, 393, 395, 468, 479, 480, 481–7, 489, 493, 494A, 494B, 496, 497, 509, 515.

Very widely distributed, and found at all depths down to 4344 m. at St. WS 468 in the Scotia Sea, where two specimens were obtained. But the majority of the records are from less than 1000 m., and the stations at which the species is common or frequent, viz. Sts. 175, 180, 190, 200, 206; WS 482, 485 and Port Lockroy, are all under that depth, and mostly under 200 m. At the remaining stations it is rare or very rare, often represented by single specimens.

191. **Trochammina inflata** (Montagu) (F 108) (SG 134) (Plate III, figs. 41–43).

Twenty-three stations: 161, 170, 177, 180–2, 196, 360, 362; WS 395, 471, 474, 488, 494A, 498, 502, 509, 510, 513, 515–17, 555.

Nearly always rare, only single specimens at most stations. The most typical and largest specimens were found at Sts. WS 395, 488 and 513. The records extend to 4224 m. at St. WS 502, but the majority are under 1000 m.

The specimens are smaller than the British type, and there is a tendency to develop height in the spire, the test becoming highly convex on the dorsal side with inflated chambers. This is most marked at Sts. 181, 196, 360, 362, WS 494A and 509.

192. **Trochammina malovensis**, Heron-Allen and Earland (F 109) (SG 135).

Fifty-six stations: 164, 167, 170, 171, 175, 180, 186, 187, 192, 194–8, 200–4, 206, 209, 360, 362, 366, 369; Port Lockroy; 62° 57′ S, 60° 20′ 30″ W; WS 382–7, 389, 391, 394, 395, 400, 469, 476, 479, 480–6, 494A, 497, 498, 506, 507B, 509, 516, 517.

Generally distributed, and found at all depths down to 4517 m. at St. WS 400, where a single small specimen was found. At the same time it is most at home in shallow water, and the great majority of records are from under 1000 m. It is very common in the anchor mud at Port Lockroy, and also at St. WS 479, common at Sts. 175, 209, 366, WS 383, 385 and 482. The best and most typical specimens were found at Sts. 175, 366 and WS 482. There is great variation in the size attained, and also in the height of the spire. At many stations both high and low forms occur together, but at others, notably at Sts. 180, WS 385, 386 and 479, the low-spired form predominates and can hardly be separated from *T. nana*.

193. **Trochammina nana** (Brady) (F 110) (SG 136).

Sixty-nine stations: 162, 163, 167, 169, 170, 171, 175, 177, 180–2, 185, 187, 190–2, 194–6, 200, 202–4, 206, 360, 363, 365, 366, 369, 373, 377, 382; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; WS 199, 203, 377, 382, 386, 387, 391–6, 403, 480–5, 487, 488, 489, 493, 494A, 494B, 497, 507A, 507B, 509, 510, 512, 513, 515–17.

Generally distributed and found at all depths down to 4259 m. at St. WS 203, where it is very rare. Most of the records are from depths under 1000 m., and in these shallower waters the species is often of frequent occurrence, though seldom common except at Sts. 177, 190, 363, 366 and WS 482. The best specimens were observed at Sts. 170, 363, 365, WS 482 and 516. A few sessile specimens at St. 181. The species is very variable and often almost inseparable from the flattened forms of *T. malovensis*. More or less irregularly grown specimens resembling Brady's figures (B. 1884, FC, pl. xxxv, figs. 7, 8) were observed at many stations, including Sts. 170, 190, WS 482. Among them could be found specimens very similar to those figured in the Terra Nova report as arenaceous isomorphs of other species (*Truncatulina lobatula* var. *arenacea* (H.-A. and E., 1922, TN, p. 208, pl. vii, figs. 32–5), *Rotalia soldanii* var. *arenacea* (*ibid.*, p. 220, pl. vii, figs. 29–31) and *Nonionina turgida* var. *arenacea* (*ibid.*, p. 228, pl. vii, figs. 36–8)). Wiesner records and figures a new variety, *Haplophragmoides canariensis* var. *inhaerens* (W. 1931, FDSE, p. 95, pl. xii, fig. 137), which is based on one of the Terra Nova figures of *Truncatulina lobatula* var. *arenacea*, but both his figure and the original seem nearer to *T. nana* than to *Haplophragmoides canariensis*.

194. **Trochammina grisea**, sp.n. (Plate III, figs. 35–37).

One station: 363.

Test free, large, consisting of about three convolutions of six chambers, all exposed on the dorsal side, which is flattened except where it rounds off to the peripheral edge. Sutures on the dorsal side straight and distinct, but only very slightly depressed. Peripheral edge round, entire except at the last few chambers where it is slightly lobulate. Ventral side deeply depressed at umbilicus, exhibiting the last whorl of six very slightly inflated chambers; sutures more depressed than on dorsal side. Aperture a narrow slit, extending down the inner edge of the apertural face of final chamber. Colour dark grey, owing to the incorporation of black volcanic sand. Wall constructed of fine sand grains and cement, smooth but unpolished.

Diameter up to 0·75 mm.; thickness about 0·25 mm.

This large and striking form is not uncommon in 329 m. off Zavodovski Island in the South Sandwich group, but did not occur at any other station. Its dark colour is a feature common to all the Arenacea at this station, and elsewhere it might be expected to have the yellow-orange colour characteristic of the genus. It is probably closely related to *T. nitida*, with which it agrees in its depressed umbilicus, but differs in having only six chambers instead of nine to the convolution, a lobulate peripheral edge and coarser construction. In the latter respect it resembles *T. nana*, which has not a depressed umbilical area.

195. **Trochammina nitida**, Brady (SG 138).

One station: 365.

The species is curiously rare in the material, being represented by a single specimen which is not typical, having only seven chambers in the final convolution. It appears to be almost entirely composed of cement.

196. **Trochammina bradyi**, Robertson (F 111) (SG 137).

Sixty-five stations: 169, 170, 171, 177, 180, 181, 186, 190–2, 194–8, 203, 204, 206, 360, 362, 369, 382; 62° 57′ S, 60° 20′ 30″ W; WS 199, 203, 377, 383–7, 389, 391, 393, 395, 396, 471, 472, 474, 479, 480, 482–90, 493, 494A, 494B, 496, 502, 503, 509–12, 514, 515, 552, 553, 555.

Generally distributed and at all depths down to 5029 m., but not recorded at any of the stations outside the Antarctic convergence line.

It is very common at Sts. 171, 177, 181, 198, WS 383, 384, 385, 386, 479 and 483; of varying frequency at the remaining stations, and sometimes represented by only one or two specimens. Its wide distribution and frequency all over the Antarctic area is the more noticeable because of its extreme rarity in the Falklands and South Georgia, where it might have been expected to occur in similar abundance, as it is met with frequently in British dredgings and is therefore not essentially a cold-water species.

There is great variation in the size of specimens at different stations, also in the colour, which varies from yellowish white through all shades of yellow and orange to dark brown. The number of chambers visible is typically five, but at the deep-water stations WS 552, 553 and 555 specimens showing only four chambers of approximately equal size occur. They bear some resemblance to the compressed form of *Pullenia sphaeroides* which is occasionally found, also to *Haplophragmoides quadratus* (No. 164). At many stations specimens occur with the number of visible chambers exceeding five, and arranged in an irregular fashion.

197. **Trochammina globigeriniformis** (Parker and Jones) (F 110A) (SG 140).

Forty-eight stations: 163, 167, 171, 177, 181, 192, 194, 195, 198, 202, 203, 360, 362, 365, 369, 383, 385; 62° 57′ S, 60° 20′ 30″ W; WS 201, 205, 377, 384, 385, 391, 393, 395, 400, 403, 468, 469, 472, 474, 479, 483, 484, 487, 497, 503, 506, 507B, 511–15, 517, 553, 555.

Generally distributed in all areas and at all depths down to 5029 m. It is very common at St. WS 479, common at Sts. 171, WS 395 and 483, frequent at Sts. 192, 198, WS 384, 507 B, 515 and 517, more or less rare at the remaining stations. As a rule specimens are small and not very typical, the best were found at Sts. 383, 385, WS 469, 507 B and 515.

198. **Trochammina globulosa, Cushman (Plate III, figs. 32–34).**

Trochammina globulosa, Cushman, 1918, etc., FAO, 1920, p. 77, pl. xvi, figs. 3, 4.

Ten stations: 177; WS 199, 468, 471, 495, 507 A, 507 B, 515–17.

Frequent to common at Sts. WS 507 A, 507 B, 515, 516 and 517, very rare elsewhere. The specimens are rather smaller than topotypes of Cushman's species from the West Indies, with which I have compared them, but otherwise appear to be identical except in their paler colour, due to a lesser proportion of ferruginous cement. The aperture varies considerably in size, sometimes being large as in *Globigerina bulloides*, at other times an inconspicuous crevice in the same position.

The species is closely allied to *Trochammina globigeriniformis*, but the name may be usefully employed to separate some of the kindred organisms usually assigned to that species. Cushman's records were from the western shores of the North Atlantic, but the species is probably widely distributed.

199. **Trochammina inconspicua, sp.n. (SG 139) (Plate III, figs. 38–40).**

Trochammina turbinata, Earland *non* (Brady), 1933, SG, p. 86, No. 139.

Forty stations: 169, 171, 177, 185, 191, 192, 196, 197, 203, 204, 206, 360, 362, 385; 64° 56′ S, 64° 43′ W; WS 199, 203, 377, 383, 386, 387, 394, 471, 474, 479, 480, 485, 486, 494 A, 495–7, 503, 507 B, 509, 510, 515, 516, 552, 553.

Test minute, free, thin walled and very fragile; rounded in form, consisting of about three convolutions in a low trochoid spire. Three to five rather inflated chambers, rapidly increasing in size, form a convolution, all exposed on the dorsal surface, the ventral side showing only the chambers of the final convolution. Aperture a small arched opening on the inner edge of the final chamber. Sutures flush and inconspicuous, the structure of the test being usually obscure except in balsam-mounted specimens. Constructed of fine mineral grains with little cement. Colour pale yellowish grey. Size very variable; average diameter about 0·15 mm., height about the same.

This little organism, which was recorded in the South Georgia report under the name *T. turbinata* (Brady) (SG 139), can no longer be regarded as a pauperate form of that species, as its plan of growth is a regular trochoid spiral, while an examination of specimens of *T. turbinata* from the type locality shows that the plane of convolution changes during growth. In this respect it resembles the organism for which I have instituted the new genus *Recurvoides* (see p. 90), and Brady's species must be transferred to that genus as *Recurvoides turbinatus* (Brady).

Although widely distributed in the Antarctic *Trochammina inconspicua* is never very common, and its fragility makes it difficult to obtain a series of perfect specimens. It is less rare at Sts. 171, 191, 192, 196 and WS 383 than elsewhere. The range of depth extends to 5029 m. at St. WS 553, but the majority of the records are in moderate depths. It is probably related to the group of *Trochammina globigeriniformis*, and is not easily distinguished from small individuals of that species.

Pearcey has recorded *T. turbinata* (Brady) from the Weddell Sea (P. 1914, SNA, p. 1011), but without an examination of his specimens it is not possible to determine their identity.

200. **Trochammina tricamerata**, sp.n. (Plate III, figs. 50–52).

Six stations: 175, 177; WS 482, 515, 517, 555.

Test free, biconvex; on the dorsal side showing three convolutions each of rather more than three chambers, slightly inflated, sutures somewhat depressed; on the ventral side showing only the last convolution of three very inflated chambers, with intervening sutures deeply excavated. Aperture a small curved slit on inner edge of final chamber. Wall thin, of rather coarse sand grains with much ferruginous cement, smooth but not polished. Colour various shades of brown and yellow.

Maximum breadth about 0·35 mm.; thickness up to 0·25 mm.

Very rare, never more than two or three specimens at a station, the best at Sts. 175 and 177. The depths range between 50 and 3850 fathoms, but the latter depth at St. WS 555 is exceptional, and only one small specimen was found there. It appears to be confined to the Bransfield Strait and Bellingshausen Sea, and is probably related to *T. globulosa* (No. 198), differing in its fewer chambers and lesser degree of inflation.

201. **Trochammina alternans**, sp.n. (Plate III, fig. 24–27).

Five stations: 360; WS 203, 400, 468, 516.

Test free, in outline like the figure eight, all chambers visible on the dorsal side, which is convex, rising to the earliest chambers at the summit of a short spire. These earliest chambers, four or five in number, are minute, dark in colour, and spirally arranged. Subsequent chambers are added in pairs, opposite to each other; they are inflated and increase rapidly in size. On the ventral side only the last pair of chambers and a portion of the ante-penultimate chamber are visible. Aperture an arched opening on the edge of the final chamber. Constructed of fine sand and cement, thin-walled but firm. Colour pale yellow except for the darker earliest chambers.

Greatest breadth up to 0·4 mm.; least breadth up to 0·3 mm.; height about 0·2 mm. Very rare at all stations, which are in the deep water of the Scotia and Bellingshausen Seas, 2611–4517 m. It is a very distinctive form allied to *T. globulosa*, but characterized by its spiral having only two chambers to the convolution.

202. **Trochammina vesicularis**, Goës (Plate III, figs. 44–46).

Trochammina vesicularis, Goës, 1894, ASF, p. 31, pl. vi, figs. 235–7.

Three stations: 170, 360, 363.

Common at St. 363, off Zavodovski Island in the South Sandwich group, depth 329–278 m.; very rare at St. 360 in 3264 m.; and a single specimen at St. 170, off Cape Bowles, Clarence Island, 342 m.

This elegant little species was described by Goës from 350 m. in the Spitzbergen Sea, very rare. I know of no other record, and its occurrence in such numbers at a few stations in the Antarctic is an interesting problem of distribution.

The specimens appear to comply almost exactly both with the figure and description of Goës, but are more solidly constructed, a good deal of ferruginous cement being employed, and there is a very slight umbilical depression. The original description is as follows (translation): Test trochoid and subglobose, very thin, five to seven convolutions, about five chambers in the last convolution, half-embracing, inflated; oral face not umbilicate. Pale rusty or yellowish colour, translucent. Diameter 0·40 mm.

203. **Trochammina conica**, sp.n. (Plate III, figs. 47–49).

Two stations: 200; WS 517.

Test conical; dorsal side exhibiting all convolutions, four or five in number, each of three chambers inflated and rapidly increasing in size; sutures depressed. Ventral side showing only the three chambers of the final convolution which are very inflated; deeply excavated at the umbilicus. Aperture a small arch in the middle of the inner face of the final chamber. Composed of rather coarse sand grains and cement, surface neatly finished but not smooth. Colour deep red or brown at apex, lighter towards the last chambers.

Diameter about 0·2 mm.; height about the same. Two specimens at St. WS 517 in 2770 m., and one at St. 200 in 345 m., somewhat rougher in construction.

This little species has considerable resemblance to *Valvulina conica*, and bears the same relation to that species that *Trochammina squamata* does to *Valvulina fusca*. It is distinguishable by its aperture and minute size.

204. **Trochammina discorbis**, sp.n. (Plate III, figs. 28–31).

Three stations: 360; WS 471, 516.

Test free, minute, a trochoid spiral of 3–4 convolutions, with five or sometimes only four chambers in the final convolution. Dorsal surface highly convex, exhibiting all convolutions, which are slightly "stepped" one below another. Ventral surface nearly flat but with a deeply sunk umbilicus, exhibiting only the chambers of the final convolution. Sutural lines recurved on dorsal side, straight on ventral, slightly depressed. Peripheral edge subacute. Aperture a small slit on inner edge of final chamber on ventral side. Constructed of very fine sand with much cement. Colour dark ferruginous brown, sometimes nearly black, but occasionally lighter. Surface smooth but not highly polished.

Breadth up to 0·2 mm.; height about 0·07 mm.

This pretty little species is an almost perfect isomorph of some of the smaller forms of *Discorbis* of the *D. rosaceus* group. The few records are in deep water, 2611–3264 m., in the Scotia and Bellingshausen Seas, and widely separated. A good many specimens were found at St. 360 but only single individuals at the other stations.

Egger (E. 1893, FG, p. 264, pl. v, figs. 19–21, 48–52) describes and figures a little species, *Trochammina plana*, which bears some resemblance to my species, having five chambers in the convolution and a flat ventral surface with sunken umbilicus. But the dorsal surface is almost flat in his figure and he says it is "raised only a little", whereas in *T. discorbis* the spire is quite high for the diameter of the shell. At the same time Egger's species is nearer to mine than any other with which I am acquainted, and they may be related.

Egger's specimens were from West Australia, 357 m., 18° 52′ S, 116° 18′ E.

Genus **Globotextularia**, Eimer and Fickert, 1899

205. **Globotextularia anceps** (Brady) (F 112) (SG 141).

Thirty-three stations: 169, 170, 175, 177, 180, 181, 196, 204, 362, 369, 383; WS 204, 385, 468, 471, 476, 479, 487, 494A, 498, 502, 506, 507A, 507B, 509–12, 515–17, 552, 553.

Generally distributed in all the areas and at all depths, but rarely more than one or two specimens at a station, except at St. 177, where it was not infrequent and larger than usual. The best examples were noticed at Sts. 170, 175, 177, 180, 181, WS 204, 385, 468, 494A, 507B, 510, 511, 517 and 552. At most of these stations the specimens were considerably larger and more coarsely constructed than elsewhere. In several instances this larger variety occurs with the smaller form.

Genus **Ammosphaeroidina**, Cushman, 1910

206. **Ammosphaeroidina sphaeroidiniformis** (Brady) (SG 142).

Four stations: 170, 363; WS 201, 469.

Excellent specimens were found at each of these stations but never with any frequency. The species is, however, not easily distinguishable, which may account for the paucity of records here and elsewhere. The four stations vary greatly in depth, two being under 400 m. and the others about the 4000 m. line.

Genus **Cystammina**, Neumayr, 1889

Note. On grounds of priority *Cystammina* must supersede *Ammochilostoma*, Eimer and Fickert, 1899.

207. **Cystammina argentea**, sp.n. (Plate IV, figs. 17–19).

Five stations: WS 377, 400, 496, 497, 514.

Test minute, a very elongate oval with almost parallel edges; only three chambers visible externally, the last two nearly concealing the earlier of the three. Chambers not inflated, sutures obscure; aperture an arched slit under the edge of the final chamber. Constructed of very fine material, perhaps mud. Colour silvery grey.

Length about 0·2 mm.; breadth at widest point near aperture 0·09 mm.

This is a very minute organism, and was at first thought to be a young or pauperate form of *C. pauciloculata* (Brady); but its uniform size, distinctive colour and separate distribution show that it is specifically distinct. *C. argentea* does not occur at any station where *C. pauciloculata* was recorded, and young individuals of the latter species are ferruginous, and have the same short turgid chambers as the adult shell. It is very rare everywhere except at Sts. WS 496 and 497, from each of which several specimens were obtained.

208. **Cystammina pauciloculata** (Brady) (SG 144).

Fourteen stations: 360, 362, 382–4; WS 403, 468, 471, 472, 474, 503, 516, 552, 555.

Generally distributed but always rare or very rare. All the records are from deep water between 2611 and 4845 m. The best and largest specimens were found at Sts. 362, WS 468, 471, 472 and 474, all being in the Scotia Sea.

Genus **Ammocibicides**, gen.n.

Test free or sessile, possibly loosely attached in the early stages, subsequently assuming a free existence. Consisting of an indeterminate number of chambers, generally compressed, sometimes becoming inflated later on. Chambers arranged at first in a flattened evolute spiral resembling sessile specimens of *Cibicides*; subsequently adding chambers of irregular shapes without settled plan, uniserial, biserial, continuing the original spiral in a more or less irregular fashion, or altogether amorphously. The outer edges of the chambers are sometimes rather thickened, and generally produced into irregular cusps and processes. As a rule all the chambers are visible on the superior surface and separated by slightly depressed sutures, but occasionally chambers are superimposed on earlier growth. The inferior side is flat or altogether irregular, conforming in shape to the surface on which the organism grew. The aperture is a circular hole, or narrow slit with thickened lip, placed anywhere on the edge or superior surface of the final chamber, but is not always visible. Secondary apertures of a similar kind are occasionally seen on earlier chambers. It is presumed that the various chambers communicate through such apertures, but except in a few specimens it has not been possible to confirm this. In the majority no communicating passage can be seen, and the protoplasm probably passes through interstices in the walls, as in many other Foraminifera. The wall is thin but firm, smooth and sometimes highly polished. It is composed of very fine sand or mud with a large proportion of grey cement. Individual sand grains of larger size are rarely seen. The colour varies from nearly white to dark grey.

Ammocibicides was found only in the deepest water of the Scotia Sea and Drake Strait, where it lives on the surface of the *Globigerina* ooze, the under surface of specimens often showing rounded depressions where the test has moulded itself on other organisms. At the same time I have not seen any specimens with *Globigerinae* attached, so the bond must be very slight. A single large biserial specimen (cf. *Dyocibicides*), and a smaller irregular specimen firmly attached to a manganese nodule at St. 384, represent the only evidence of a permanent sessile habit.

209. **Ammocibicides proteus**, sp.n. (Plate III, figs. 53, 54, and Plate IV, figs. 1–7).

Six stations: 384–6; WS 202, 205, 403.

Rare or very rare at all the stations, which range between 3638 and 4773 m.

The description of the genus is almost sufficient for the genotype species. It is a variable organism, hardly any two of the specimens found being similar. In its earliest stages it is comparatively regular in formation, the chambers being arranged in an open spiral, and resembling an extremely pauperate variety of *Cibicides lobatulus* which occurs in its company at several stations. When these specimens are dead and decomposed, they can only be separated from *Ammocibicides* by their characteristic aperture, or by an examination in fluid which brings out their perforate character. In its more advanced stages of growth *Ammocibicides proteus* continues its resemblance to *Cibicides*, the uniserial and biserial stages bearing great resemblance to the forms which have been named *Dyocibicides* (C. and V. 1930, SWF, p. 30), and *Rectocibides* (Cushman and Ponton in C. 1925, etc., LFR, 1932, p. 2). *Rectocibicides* indeed has projecting tubular processes very like the cusps on the edges of *Ammocibicides proteus*, but they are distinct apertures, while I can trace no openings in the cusps on *Ammocibicides*.

Average specimens are about 0·5 mm. in diameter; abnormal individuals up to 1·5 mm. in length.

Nearly all the specimens found preserve the flattened formation, although later chambers tend to become inflated. At Sts. 386 and WS 202 a few specimens were found which have grown irregularly, and with inflated chambers throughout. It is possible that they may represent a distinct species, but more material is required to settle this point. At present they may be regarded as abnormal growths.

It is not surprising to find that an organism of such simple structure as *Ammocibicides* has a long geological history. Some time ago an American correspondent, Mrs H. J. Plummer of Austin, Texas, sent me some Eocene material from Lower Wilcox strata at Ozark, Alabama, on which a paper has been published ("An Eocene Foraminiferal Fauna of Wilcox Age from Alabama"—J. A. Cushman and G. M. Ponton in C. 1925, etc., LFR, 1932, pp. 51–72, pls. vii–ix). In the material I found specimens of an organism which is certainly *Ammocibicides*, though it does not attain the wild growth of the Discovery species. As it is not described in the paper referred to, I propose, with Mrs H. J. Plummer's consent, to name it after one of the authors.

210. **Ammocibicides pontoni**, sp.n. (Plate IV, figs. 8–12).

Test free, but possibly sessile in life, planoconvex, exactly resembling in its early stages neat specimens of *Cibicides lobatulus*. Ventral side convex, exhibiting five inflated chambers with depressed sutures. Dorsal side quite flat, as though adherent in life to a flat surface, sutures obscure and chambers hardly discernible, though more distinct when moistened. Peripheral edge acute; aperture, when present, a curved slit with lips, on the outer edge of the final chamber. Further growth is made by the addition of one or more chambers extending in a straight series from the final chamber of the early spiral series, and sometimes partly embracing that chamber. I personally have not seen any specimens with more than two chambers in the second series, and none resembling the abnormal growths of the recent species *Ammocibicides proteus*. The test is thin and built of fine sand grains, much larger than those used by the recent species, with an excess of grey cement. Surface smooth and neatly finished, but not polished. Colour light grey.

Diameter of early spiral stage about 0·4 mm.; thickness about 0·2 mm.; length of specimen with two extended chambers 0·75 mm.; breadth at widest point 0·5 mm.

Sub-family *LOFTUSINAE*

Genus Cyclammina, Brady, 1876

211. **Cyclammina cancellata**, Brady (F 114) (SG 147).

Thirteen stations: 362, 383–5; WS 403, 471, 495, 502, 505, 506, 507 A, 552, 555.

Frequent and large, both megalospheric and microspheric, at St. 383 in the Drake Strait, depth 3744 m.: very fine microspheric specimens were also frequent at St. WS 502 in the Bellingshausen Sea, depth 4224 m. With these exceptions the species is rare, though widely distributed, seldom more than one or two specimens at a station. With the exception of St. WS 502 the specimens from the Bellingshausen Sea stations (WS 495, 505, 506 and 507 A) are small, and far from typical as compared with the rest.

212. **Cyclammina orbicularis**, Brady (SG 148).

Eight stations: 369, 382; WS 384, 403, 495, 502, 505, 555.

Good specimens everywhere, but never more than one or two, except at St. 369 in the South Sandwich Islands, depth 1767 m., and at WS 495 in the Bellingshausen Sea, depth 2582 m., where the species is frequent. The stations are scattered over the entire area, depths ranging between 1500 and 4224 m.

213. **Cyclammina pusilla**, Brady.

Cyclammina pusilla, Brady, 1879, etc., RRC, 1881, p. 53; 1884, FC, p. 353, pl. xxxvii, figs. 20–3.
Cyclammina pusilla, Goës, 1894, ASF, p. 32, pl. vi, figs. 242–4.
Cyclammina pusilla, Cushman, 1910, etc., FNP, 1910, p. 111, fig. 172; 1918, etc., FAO, 1920, p. 56, pl. xi, figs. 4–6.

Nine stations: 383; WS 495, 502, 503, 505, 506, 507 A, 507 B, 517.

Common at Sts. WS 502 and 503, both of which are in depths of over 4000 m.; frequent at all the other stations except WS 506 and 517. Depths range between 572 m. at St. WS 507 A and 4224 m. at St. WS 502. Except St. 383, which is in the Drake Strait, all the stations are in the Bellingshausen Sea; its absence from the Weddell Sea and Scotia Sea stations is rather remarkable, as the species has a world wide distribution. Pearcey recorded it from Scotia stations in both the Scotia and Weddell Seas, but nowhere common (Pearcey, 1914, SNA, p. 1009).

214. **Cyclammina bradyi**, Cushman.

Trochammina trullissata (*pars*), Brady, 1884, FC, p. 342, pl. xl, fig. 13 (only).
Cyclammina bradyi, Cushman, 1910, etc., FNP, 1910, p. 113, fig. 174; 1918, etc., FAO, 1920, p. 57, pl. xi, fig. 3.

Eight stations: 373, 384; WS 502, 506, 517, 552, 553, 555.

Rarely more than a single specimen at each station, and mostly microspheric; but megalospheric specimens were found at St. WS 517, and also in company with microspheric at St. WS 553. The stations are all in deep water between 2515 and 5029 m. in the Weddell, Scotia and Bellingshausen Seas, except St. WS 506 which is off the continental ice in the Bellingshausen Sea, depth 584 m. The specimens sometimes have sand grains included in the cement, an unusual feature in this species.

Sub-family *SILICININAE*

Genus Spirolocammina, gen.n.

Test minute, compressed, consisting of several pairs of chambers arranged on a spiroloculine plan, but with a very slight sigmoiline curve in the long axis. Aperture terminal, on a produced neck, without tooth. Test composed of extremely minute mineral particles imbedded in a chitinous wall, and resistant to acid. Wall of test thin, smooth but not polished.

The fact that the test is not in any way affected by treatment with hot nitric acid, the thin chambers remaining uncollapsed, proves the absence of any calcareous constituent and its close relationship to *Miliammina*. Four of the plans of growth associated with the calcareous Miliolidae have now been shown to occur also in the Silicininae, viz. the spiroloculine in *Spirolocammina*, the triloculine and quinqueloculine in *Miliammina*, and the sigmoiline in *Silicosigmoilina*.

215. **Spirolocammina tenuis**, sp.n. (Plate IV, figs. 13–16).

Six stations: 360, 382; WS 199, 400, 472, 502.

Test minute, compressed, consisting of two to three pairs of tubular chambers arranged in a spiroloculine plan on opposite sides of the long axis of the test. Walls of the chambers thin, smooth but unpolished, nearly white in colour, composed of extremely minute mineral particles and probably diatomaceous fragments, imbedded in a chitinous membrane. Edge of the test round, the chambers being tubular in section, somewhat enlarged at the aboral end where each chamber envelops and encloses the produced tubular neck of the preceding chamber. Aperture round and simple, at the terminal end of the produced neck. The test is not affected in any way by treatment with hot nitric acid.

There is a very slight sigmoiline curve in the arrangement of the chambers, hardly noticeable except by oblique illumination, and not in any way comparable with the pronounced spiral of *Silicosigmoilina*. Length up to 0·55 mm.; breadth 0·15 mm.; thickness 0·05 mm.

This is a very interesting little form which was at first thought to be a pauperate condition of *Sigmoilina tenuissima* (Reuss) (see No. 30); but its distribution is quite distinct, that species being confined to deep-water stations nearer the Antarctic convergence line, while *Spirolocammina tenuis* was found only in the deep water of the Scotia and Bellingshausen Seas, well inside the area of pack-ice.

The acid test is a conclusive proof of the distinction between the two forms; *Sigmoilina tenuissima* is instantly destroyed with effervescence, while *Spirolocammina tenuis* is unaffected.

Spirolocammina tenuis is very rare, even at the few stations where it was recorded, but a considerable number of specimens were found in all, the majority at St. WS 199. At St. 360 two specimens were found, one much larger than usual, the other malformed, the final chamber being out of the usual axis of growth. In depth the species ranges between 3264 and 4517 m. Owing to its minute size and colour it may have been overlooked at other stations.

I have not found it in the Terra Nova material from the Ross Sea after a careful examination of the station slides.

Genus Miliammina, Heron-Allen and Earland, 1930

216. **Miliammina arenacea (Chapman) (SG, pp. 90, 92) (Plate IV, figs. 20–24).**

Miliolina oblonga (Montagu) var. *arenacea*, var. nov., Chapman, 1914, FORS, p. 59, pl. i, fig. 7.
Miliolina oblonga var. *arenacea* (*pars*), Heron-Allen and Earland, 1922, TN, p. 66.
Miliammina oblonga (Chapman) (*pars*), Heron-Allen and Earland, 1929, etc., FSA, 1930, pp. 41–2, pl. i, fig. 6.
Miliammina arenacea (Chapman), correspondence T. D. A. Cockerell, E. Heron-Allen and A. Earland, *Nature*, June 28, 1930, and September 20, 1930.

Seventy stations: 162, 163, 167, 170, 171, 175, 177, 180, 181, 186, 187, 190, 194, 195–204, 206, 209, 365, 366, 369, 377; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; WS 377, 382–4, 386, 387, 389, 391, 393–5, 400, 474–6, 479, 480, 482–8, 494A, 494B, 496–8, 506, 507A, 507B, 509–15.

Chapman's species is generally distributed in all the areas within the Antarctic convergence line, irrespective of depth. It was not found at the few deep-water stations in the Weddell Sea, and in the shallower gatherings from the South Sandwich Islands its distribution is rather curious, for it is common at St. 366 (155–322 m.), very rare at St. 369 (1767 m.), and absent at St. 363 (329–278 m.), which otherwise has the richest fauna of them all. The deepest record is at St. WS 400 off the South Shetlands in 4517 m., where specimens are frequent but rather small. It is common or very common at many stations, and does not appear to be influenced by depth as these range between 130 m. at St. WS 389 and 1600 m. at St. 198. It is readily identified and separated from *M. oblonga* and *M. obliqua* in the adult stage owing to its straighter edges, which are nearly parallel and less rounded than in the other species. Young individuals are not so easily distinguished. Apart from size very little variation was observed in the species. The colour varies from nearly white to dark grey or almost black at a few stations where the material was of volcanic origin.

217. **Miliammina obliqua, Heron-Allen and Earland (SG 150).**

Forty-seven stations: 162, 167, 181, 185–7, 191, 192, 194, 196, 197, 199, 202, 203, 206, 209, 365, 366, 369, 377; 62° 57′ S, 60° 20′ 30″ W; WS 383–7, 391, 393, 400, 476, 479, 480, 482–8, 494A, 494B, 496, 497, 511, 512, 514, 515.

Although very generally distributed within the Antarctic convergence line, more than half of the records are in the Bransfield Strait and South Shetlands area, and of twenty-one stations at which specimens vary from frequent to very common, the majority are within this area. At the other stations it is rare or very rare. It is very common at St. WS 479 (1523 m.), and common at Sts. WS 385 (1838 m.) and WS 483 (1420 m.), all in the Bransfield Strait. It is also common at St. 167 (344 m.) in the South Orkneys, and at WS 512 (652 m.) in the Bellingshausen Sea. Moderate depths, under 600 m., appear to be most favoured, but there is an exception in St. WS 400, off the South Shetlands, where the species is frequent in 4517 m. With this exception the deepest record is at St. WS 383, where it is frequent in 2085 m. There is considerable range in the size and development of specimens, and the species is not always easy to identify in company with young individuals of *M. arenacea.*

218. **Miliammina oblonga**, Heron-Allen and Earland (SG 149).

Fifty-eight stations: 167, 169, 170, 171, 177, 180, 181, 185–7, 190–2, 194–6, 198–200, 202, 204, 206, 209, 365, 369, 377; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; WS 382–7, 391, 393–6, 399, 400, 475, 476, 479, 480, 482, 483, 485–9, 496, 510–13, 515.

Generally distributed in all the areas within the Antarctic convergence line, and sometimes very common, notably at Sts. 167 in the South Orkneys (244 m.), WS 384, 385, 386, 395 and 479, all of which are in the Bransfield Strait with depths varying between 297 and 1957 m., and St. WS 512 in the Bellingshausen Sea, depth 652 m. It is rare at the South Sandwich stations, and like all the other species of the genus is absent from the deep-water stations in the Weddell Sea. Depth does not appear to have much influence, within limits, as the range extends between 50 and 4517 m., and its frequency is as variable as the limits are wide. The species runs very true to type, and only one abnormal specimen composed of two individuals fused at divergent angles was observed. This was found at St. 204 (843 m.) in the Bransfield Strait, where the species was frequent.

219. **Miliammina lata**, Heron-Allen and Earland (SG 151).

Sixty stations: 162, 167, 171, 175, 177, 180, 181, 185–7, 194, 196, 197, 199, 200, 202–4, 206, 363, 366; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; WS 382, 384–7, 391–6, 400, 475, 476, 480, 482–9, 494A, 494B, 496, 497, 506, 507A, 507B, 509–15.

This species is generally distributed all over the area within the Antarctic convergence line, at stations of moderate depth. The only stations deeper than 1000 m. at which it occurs with any frequency are WS 384 (1957 m.), WS 385 (1838 m.) and WS 400 (4517 m.). At all these stations the specimens are very small and pauperate. St. WS 400 is in the deep water of the Drake Strait, off the South Shetland Islands, while WS 384 and 385 are in the Bransfield Strait, in which area the species is rare, irrespective of depth, an exception being St. 177 (1080 m.), where specimens were common and well developed. It is common and large at St. 363, frequent at St. 366, both in the South Sandwich Islands, where the tests are dark owing to the admixture of volcanic sand; common at Sts. 180, 181 and 186 in the Palmer Archipelago, specimens large and light grey in colour; frequent to very common at the series of Sts. WS 496–515 in the Bellingshausen Sea, at all of which the specimens are nearly white and very well developed. At all other stations with few exceptions it is comparatively rare and often represented by one or two specimens. Very little variation was observed except in size and colour.

220. **Miliammina circularis**, Heron-Allen and Earland (Plate IV, figs. 25–29).

Miliammina circularis, Heron-Allen and Earland, 1929, etc., FSA, 1930, p. 44, pl. i, figs. 18–21.

Nine stations: 177, 180, 181, 182, 186, 203, 363, 366; WS 488.

This species appears to be confined to a narrow belt of stations running from the

South Sandwich Islands through the Bransfield Strait to the Palmer Archipelago. Never common, it occurs with some frequency at Sts. 363 and 366 in the Sandwich group, and at St. 181 in the Palmer Archipelago. At the remaining stations it is rare or very rare. Depths range between 155 and 1080 m., but it is most frequent and attains the largest size under 350 m. The colour is usually very light grey, almost white at St. 181, but darker at Sts. 363 and 366 owing to the use of black volcanic sand in construction.

Family TEXTULARIIDAE

Sub-family *SPIROPLECTAMMININAE*

Genus Spiroplectammina, Cushman, 1927

221. Spiroplectammina biformis (Parker and Jones) (F 115) (SG 152).

Sixteen stations: 167, 169, 187, 191, 192, 194, 195, 209; Port Lockroy; 62° 57′ S, 60° 20′ 30″ W; WS 395, 485, 486, 488, 494A, 516.

Common in the anchor mud from Port Lockroy, and frequent at St. 169 in 244–344 m. More or less rare at the remaining stations, which range down to 2611 m.

222. Spiroplectammina typica, Lacroix.

Spiroplectammina typica, Lacroix, 1932, TPCM, p. 6, text-figs. 2–3.

Two stations: 360, 369.

Single specimens from 1767 m. at St. 369 in the South Sandwich Islands, and St. 360 (3264 m.) in the Scotia Sea agree with Lacroix's figures and description. The species is distinguished by its very thin initial spiral, the subsequent chambers increasing rapidly in thickness; also by its roughly constructed test, sand grains of varying sizes being utilized.

223. Spiroplectammina subcylindrica, sp.n. (Plate IV, figs. 33–35).

Nine stations: 360, 382, 386; WS 400, 469, 471, 472, 502, 503.

Test minute, sub-cylindrical, rounded at the initial extremity, obtusely pointed at the oral end. No perceptible decrease of thickness at the initial extremity. Sides parallel, sutures indistinct and nearly flush. Aperture small, normal. The surface is uniformly rather rough owing to the size of the sand grains and the small quantity of cement employed in construction. Colour yellowish brown.

Owing to the rough surface and flush sutures very little structure can be made out in opaque specimens. Mounted in balsam the test is seen to be composed of an initial closely coiled spiral of 6–8 chambers, followed by 2–4 pairs of textularian chambers. The walls are rather thick for the size of the organism.

Average length 0·25 mm.; breadth 0·13 mm.; thickness 0·1 mm.

This is a very distinctive little form, and appears to be confined to deep water in the Scotia and Bellingshausen Seas, the records ranging from 3264 to 4773 m. It is common at St. WS 503, but the specimens are undersized; frequent at WS 471, 472; rare at the remaining stations.

224. Spiroplectammina filiformis, sp.n. (Plate IV, figs. 30–32).

Seven stations: 360, 362, 383; WS 203, 471, 472, 474.

Test minute, almost circular in section; initial spiral small but prominent, containing the proloculus encircled by 5–6 chambers; a textularian series of 6–10 pairs of chambers follows; the chambers increase in size very gradually, so that the sides of the shell remain almost parallel; sutural lines slightly depressed.

Colour a dull rusty brown, with lighter patches; surface smooth but not highly polished. Specimens mounted in balsam show that the wall is thin and largely composed of cement, incorporating only a small proportion of minute sand grains.

Length up to 0·5 mm.; maximum breadth about 0·07 mm.

This little species appears to be confined to the deep water of the Scotia Sea and Drake Strait, the stations ranging between 2813 and 4259 m. It is frequent at Sts. WS 471 and 472, rare or very rare elsewhere. The two specimens found at St. 362 were very small and light coloured, but agree in structure with the type at the other stations.

Genus Spiroplectella, gen.n.

Test arenaceous, trimorphous, commencing with a spiral series of chambers, the peripheral edge of which is in line with, and in the same plane as the edge of the succeeding series; followed by a series of chambers arranged on a textularian plan, and concluding growth with a third series arranged in a straight line.

The organism figured and described by Brady under the incorrect name *Spiroplecta annectens* (Parker and Jones) (B. 1884, FC, p. 376, pl. xlv, figs. 22, 23) should in future be known as *Spiroplectella annectens* (Brady), as it has the trimorphous characters of my genus. It has no resemblance to *Textularia annectens*, Parker and Jones, a fossil from the Gault. The original illustration of this species (P. and J. 1859, etc., NF, 1863, p. 92, text-fig. 1) is not only crude but incorrect, as it shows the early spiral portion turned as a crozier to one edge of the shell, which is also drawn much narrower than it is. Brady may have been misled by this figure, as it does not appear from his text that he was familiar with the fossil type.

The types of Parker and Jones are in the Geological Department of the British Museum (Natural History), Catalogue No. Parker Coll. VI, No. 34, trays 4, 5. The uniserial portion is small, passing rapidly into the textularian series which widens considerably before contracting at the junction with the uniserial portion. The aboral extremity is trihedral, i.e. the initial spiral, if spiral it be, is turned over at right angles to the edges of the test, and the observer, looking at the biserial chambers, sees only the edge of the spiral portion.

A better figure of Parker and Jones' species is to be found in Chapman's *Gault of Folkestone* (C. 1891, etc., GF, 1892, p. 750, pl. xi, fig. 3 *a*, *b*) where the initial portion is correctly represented in the drawing, and properly described as being "almost at right angles to the succeeding biserial portion". The uniserial portion does not attain the dimensions of the type, never exceeding a single chamber either in the Gault of Folkestone or of Reigate, Surrey, where I myself have found the species.

Cushman selected *Textularia annectens*, Parker and Jones, as the genotype of *Spiroplectinata*, Cushman, 1927. He then (C. 1928, F, p. 235) described it as having the early chambers planispiral, later biserial and finally uniserial, and placed it among the hyaline

Heterohelicidae, very far away from *Spiroplectammina*, Cushman, 1927, which is with the arenaceous Textulariidae. He has since then, in the second edition of his book (C. 1933, F, p. 114), removed *Spiroplectinata* to the Verneuilinidae, stating that the early chambers are triserial. In this view he is in disagreement with the original authors, and with Chapman. I agree with their view that the early chambers are spiral.

In any case the distinction between *Spiroplectella* and *Spiroplectinata* is complete. If Cushman's later interpretation is correct, the two are widely separated; if it is not, we have two closely allied genera in one of which, *Spiroplectella*, the edge of the spiral faces the edge of the remainder of the test, in the other, *Spiroplectinata*, the edge of the spiral is towards the face of the test.

225. **Spiroplectella cylindroides**, sp.n. (Plate IV, figs. 36–38).

One station: 360.

Test minute, arenaceous, commencing with a spiral having 4–5 chambers in the outer convolution, followed by 2–5 pairs of chambers on a textularian plan, and ending with a straight series of uniserial chambers, up to nine in number, and circular in section. The spiral portion is only a little wider than the textularian series, and from its junction there is a very gradual increase in width to the oral extremity. The whole test resembles a stout cudgel marked with rings (the sutures), and slightly flattened and expanded at one end (the spire). Sutural lines distinct, slightly depressed, and often darker in colour than the walls of the chambers. Oral aperture simple and terminal, sometimes on a produced nipple. Constructed of very fine mineral grains with excess of cement. Colour ferruginous brown of varying degrees of intensity, usually dark.

Length 0·3–0·4 mm.; width at spiral 0·05–0·055 mm., at final chamber 0·05–0·06 mm.

About a dozen specimens were found in the sounding from St. 360, so the species must be of frequent occurrence there. It was not seen at any other station. Apart from its trimorphous development it has structural differences when compared with *Spiroplectammina filiformis*, to which it bears some superficial resemblance. The spiral portion is less prominent, the increase of width of chambers much more gradual, and it uses fewer and finer mineral grains in its construction.

Sub-family *TEXTULARIINAE*

Genus **Textularia**, Defrance, 1824

226. **Textularia gramen**, d'Orbigny (F 119).

One station: WS 204.

A single small specimen from 3328 m. in the Scotia Sea.

227. **Textularia paupercula**, sp.n. (Plate V, figs. 27–29).

Eight stations: 169; WS 377, 496, 497, 506, 512, 513, 516.

Test minute, rather compressed, about three times as broad as long, consisting of 4–6 pairs of chambers gradually increasing in size, sutures obscure, slightly depressed, marginal edge rather sinuous, aperture normal. Constructed of fine sand without visible cement; wall thin and fragile; surface rather rough; colour light grey.

Average length 0·25 mm.; greatest breadth 0·12 mm.; thickness 0·07 mm.

Very rare everywhere but a good many specimens were obtained in all, the greater number at St. WS 496. The stations are in the Bellingshausen and Scotia Seas and the depths range between 534 and 2611 m., the shallower records being as usual in the Bellingshausen Sea.

228. **Textularia catenata**, Cushman (Plate IV, figs. 44–47).

Textularia catenata, Cushman, 1910, etc., FNP, 1911, p. 23, figs. 39, 40.
Textularia catenata, Cushman, 1918, etc., FAO, 1922, p. 12, pl. vi, fig. 3.

Six stations: 384–6; WS 403, 507A, 507B.

Frequent and quite typical at Sts. 384 and 385; typical but rare or very rare at Sts. 386 and WS 403. All these stations are in the deep water of the Drake Strait and Scotia Sea, 3638–4773 m., and St. 386 is outside the Antarctic convergence line.

The other two records rest on single specimens at Sts. WS 507A, 507B which are far to the south in the Bellingshausen Sea, 572–580 m. The specimens are not typical but I think they may be referred to *T. catenata*, though thicker and shorter than the type.

In its somewhat coarse arenaceous construction Cushman's species is distinctive, as compared with the smooth-surfaced specimens figured by Fornasini under the names *Sagraina affinis* (F. 1883, FPS, p. 189, pl. ii, fig. 10) and *Textilaria heterostoma* (F. 1896, TC, pl. O, figs. 6–12), but structurally there is no difference and it is questionable whether Fornasini's name should not have preference on grounds of priority.

At St. 385 a few specimens show a tendency towards a Bigenerine formation. An example is figured.

229. **Textularia tenuissima**, Earland (SG 156) (Plate X, fig. 22).

Forty-eight stations: 169, 171, 180, 181, 187, 192, 194, 196–8, 203, 204, 360, 365, 369; Port Lockroy; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; WS 199, 377, 383–5, 391, 395, 400, 471, 472, 479, 480, 482, 483, 485–7, 494A, 496, 497, 506, 507A, 507B, 509–15.

Very widely distributed in all areas and at all depths. It is common at Sts. 169, 171, WS 384, 472 and frequent at many other stations. The megalospheric (A 1) form with large planospire is very rare, but was observed at Sts. 198 and WS 485 in company with the megalospheric form A 2 and the microspheric form B. At Sts. 181 and WS 496 both A 1 and A 2 forms occurred without form B. The greater number of specimens belong to the form A 2 with small megalosphere, but excellent microspheric forms are frequent, especially at Sts. 169 and 171. At some of the more southern stations, notably Port Lockroy and St. WS 509, an exceptionally long and slender variety occurs which is figured. It is so fragile in construction that the chambers collapse on drying, and as no perfect examples were found it is not possible to say whether they were megalospheric or microspheric, or to what size a perfect specimen attains. The fragment figured measures 0·5 mm. in length with 0·05 mm. greatest breadth. The species has recently been recorded as of frequent occurrence in the Bay of Whales, Ross Sea, 280 fathoms (W. 1934, FRS, p. 2).

230. **Textularia wiesneri**, Earland (SG 155).

Twenty-eight stations: 169, 175, 177, 190, 195, 196, 360, 363, 365, 366, 373; WS 201, 203, 386, 387, 389, 471, 472, 474, 480, 482–4, 494A, 507B, 509, 512, 516.

Generally distributed all over the area and at all depths, but except at Sts. 177 (1080 m.) and WS 203 (4259 m.), where it is common, and at St. WS 471 (3762 m.), where it is frequent, the species is usually rare and often represented by single specimens. The best and largest specimens were observed at St. WS 507B (580 m.); very typical but smaller specimens at Sts. 363 and WS 474.

231. **Textularia nitens, Earland (SG 157).**

Thirty-one stations: 169, 171, 177, 180, 190, 192, 194, 196, 197, 199, 209, 366, 369; Port Lockroy; 62° 57′ S, 60° 20′ 30″ W; WS 377, 384–6, 395, 480, 484, 489, 494A, 497, 506, 507A, 507B, 509, 515, 516.

Very good specimens were frequent in the anchor mud at Port Lockroy, also at St. WS 509 in 445 m. At the remaining stations, which are widely scattered, the species is rare or very rare. Moderate depths appear to be most favoured, the majority of the records being under 1000 m., and the deepest 2514 m. at St. 169. The species is very similar to *T.* (*Pseudobolivina*) *antarctica* (No. 232), but is distinguishable by its smaller size, its more compressed chambers, and its normally arched textularian aperture.

The species has recently been recorded from 280 fathoms in the Bay of Whales, Ross Sea (W. 1934, FRS, p. 2).

232. **Textularia antarctica (Wiesner) (Plate IV, figs. 39–43).**

Bolivina punctata var. *arenacea*, Heron-Allen and Earland, 1922, TN, p. 133, pl. iv, figs. 21, 22.
Pseudobolivina antarctica, Wiesner, 1931, FDSE, p. 99, pl. xxi, figs. 257, 258, pl. xxiii, Stereo-fig. C.

Twenty-four stations: 169, 171, 177, 181, 192, 195, 198, 369; 62° 57′ S, 60° 20′ 30″ W; WS 377, 383, 479, 480, 482, 483, 494A, 496, 506, 507B, 509, 510, 512, 514, 515.

Frequent at St. WS 509 in 445 m., rare or very rare elsewhere, but many excellent specimens were found, especially at Sts. 169, 177, WS 494A. The depths range down to 2552 m. at St. WS 377, but it seems most at home at depths under 1000 m. Specimens with a twist in the long axis were noted at Sts. 198 and WS 480, very similar to those figured in the Terra Nova report. Both megalospheric and microspheric forms were observed.

The species was originally described and figured from the Antarctic (Ross Sea), in the Terra Nova report, and, with some allied forms, was regarded as an arenaceous isomorph of the hyaline genus *Bolivina*. I think that discoveries made since the date of that report have rendered the theory of isomorphism in the Foraminifera untenable; there are too many instances of similar structural design in genera which have no possible relation to each other. Perhaps no stronger argument against the theory could be found than in *Miliammina*, where the adult shell resembles various species of *Miliolina* almost exactly, but the early stages of development (*fide* Cushman) are not milioline.

Wiesner has created a new sub-family Pseudobolivininae and the new genus *Pseudobolivina* (W. 1931, FDSE, pp. 98–99) for the reception of the Terra Nova forms, but it seems to me to be superfluous. Failing the theory of isomorphism, the genus *Textularia* appears to be sufficient for their reception. They are all normal *Textulariae* in every respect except the slit-like aperture, which is at right angles to the normal direction. But the variety of apertures already observed and admitted in the genus *Textularia* is more than sufficient to cover this further abnormality.

Genus Bigenerina, d'Orbigny, 1826

233. **Bigenerina minutissima**, Earland (SG 158) (Plate IV, fig. 48).

Six stations; 360, 362, 373; WS 199, 471, 472.

Very rare everywhere.

By an oversight the description and figures of this new species were included in the South Georgia report (SG 158). The error was discovered too late for correction in the proofs, and in the circumstances the description is repeated for convenience:

"Test very minute, rod-shaped, consisting of a large proloculus followed by three to four pairs of long narrow chambers increasing rapidly in size, but very little in width, ending with three cylindrical moniliform chambers and a terminal orifice. Sutures depressed. Constructed of small sand grains, rather large for the size of the organism, embedded in cement on a chitinous membrane. Colour pale brown. Length 0·35 mm., width 0·04 mm.... The organism is so small that it might easily have been overlooked at other stations. Its structure is not easily seen, unless the specimens are mounted in balsam."

The only stations at which the species has been found lie outside the South Georgia area in the very deep water of the Scotia Sea, the depths lying between 2515 m. at St. 373 and 3580 m. at WS 472.

References to the two stations mentioned in the South Georgia report, viz. Sts. WS 199, 472, have also crept into that report under *Ammobaculites agglutinans* (SG 116) recorded as occurring at St. WS 472, *Ammomarginulina ensis* (SG 122) and *Clavulina communis* (SG 165), both recorded from St. WS 199. These errors are of less importance, as the three species concerned were found elsewhere in the South Georgia area.

I am indebted to Mr M. E. Challen who drew my attention to the error (see *Nature*, p. 562, April 14, 1934), for the information that this is a southern record for the genus *Bigenerina*. This appears to be the case.

As a result of the examination of additional specimens it may be added that the textularian series may have as few as two pairs of chambers, and the moniliform series up to six chambers.

Sub-family *VERNEUILININAE*

Genus Verneuilina, d'Orbigny, 1840

234. **Verneuilina bradyi**, Cushman (SG 160) (Plate V, figs. 17, 18).

Nineteen stations: 360, 362, 369, 385–7; WS 204, 377, 403, 468, 469, 471, 474, 505, 506, 507B, 516, 517, 555.

Frequent at Sts. 360, 362, 385 and 386, rare or very rare elsewhere. All the records are in deep water, 1500–4773 m., except Sts. WS 506 and 507B in the Bellingshausen Sea, where the depths were 584–580 m. Several other deep-water species also occur in comparatively shallow water in this sea.

At many stations the species occurs together with a distinctive variety characterized by a very low spire, the breadth sometimes exceeding the height. The shell wall is also darker owing to the incorporation of dark mineral grains. It has been separated by Wiesner as *V. bradyi* var. *nitens*.

235. **Verneuilina bradyi var. nitens**, Wiesner (Plate V, figs. 19–21).

Verneuilina bradyi var. *nitens*, Wiesner, 1931, FDSE, p. 99, pl. xiii, fig. 154.

Ten stations: 383–6; WS 204, 205, 403, 468, 469, 507B.

Fairly frequent at Sts. 385, 386 and WS 403, rare or very rare elsewhere. Wiesner describes his variety as "broader than the type; built of greenish white quartz with a few black augite grains, smooth and very polished". This description accords with the Discovery specimens, except that at a few stations, 383, 386, WS 205, 507B, a smooth but dull-surfaced form is found with or without the highly polished normal variety. The colour is more or less dark smoke grey and under a high power is seen to be due to the varying proportion of dark mineral grains incorporated in the test. The type species, *V. bradyi*, very seldom departs from its usual glistening white colour. There is great variation in the height of the spire. Specimens are found in which the spire is so low that the test is almost globular in shape.

Wiesner has been good enough to verify the identification of the Discovery specimens, which with one exception, St. WS 507B in the Bellingshausen Sea, 580 m., are from deep water in the Drake Strait between 3328 and 4773 m. Except at Sts. 383, 384 and WS 205 the variety occurs in company with the type species.

Wiesner's specimens were from a depth of 3410 m. (65° 15′ S, 80° 19′ E).

236. **Verneuilina propinqua**, Brady.

Verneuilina propinqua, Brady, 1884, FC, p. 387, pl. xlvii, figs. 8–12 (only).
Verneuilina propinqua, Cushman, 1918, etc., FAO, 1922, p. 56, pl. ix, figs. 10, 11.
Verneuilina propinqua, Wiesner, 1931, FDSE, p. 99, pl. xiii, fig. 153.

One station: WS 468.

Only a single, rather small, specimen from 4344 m. at St. WS 468, which is outside the Antarctic convergence line.

237. **Verneuilina scabra** (Williamson).

Bulimina scabra, Williamson, 1858, RFGB, p. 65, pl. v, figs. 136, 137.
Verneuilina polystropha, Brady (*non* Reuss), 1884, FC, p. 386, pl. xlvii, figs. 15–17.
Verneuilina scabra, Cushman, 1918, etc., FAO, 1922, p. 55.

Three stations: 170; WS 507B, 517.

This species, so abundant off the European shores of the North Atlantic, is extremely rare. Two large and typical specimens were found at St. 170, but only a single small specimen at each of the remaining stations.

238. **Verneuilina superba**, sp.n. (Plate V, figs. 30–34).

Three stations: 170, 175, 363.

Test long and slender, consisting of 4–7 series of inflated chambers, the length of each chamber being nearly double its breadth; sutures deeply impressed; aperture large but normal; colour a rich ferruginous orange becoming lighter at the oral end; surface smooth, not polished but rather glittering owing to the light reflected from the sand grains incorporated in the wall of the test, which is very thin.

Length up to 1·30 mm. or more; breadth and thickness at oral extremity up to 0·40 mm.

This striking species has an extremely restricted distribution, being confined to three stations which, however, are some distance apart. It is not uncommon at St. 170, rarer elsewhere. St. 175 is in the Bransfield Strait; St. 170 is at Clarence Island, and St. 363 in the South Sandwich Islands. The depths range between 200 and 342 m. It is very remarkable that it was not seen at any of the intermediate stations. *V. superba* belongs to the group of *V. scabra* (Williamson) (No. 237) but cannot be confused with that species. In its graceful outline, inflated chambers and deep sutures, it is not unlike fig. 14 A of *Verneuilina schizea*, Cushman and Alexander (in C. 1925, etc., LFR, 1930, p. 9, pl. ii, figs. 13, 14) from the Lower Cretaceous of Texas, but is more than double the size of that species (length 0·60 mm.).

239. **Verneuilina advena**, Cushman (F 121) (SG 159).

Fourteen stations: 162, 171, 192, 194, 196, 204, 209, 366; Port Lockroy; WS 389, 395, 480, 485, 509.

Frequent at Sts. 192, Port Lockroy and WS 395, rare or very rare elsewhere. The specimens are identical with those described and figured in the South Georgia report. The depths range from "anchor mud" at Port Lockroy to 1542 m. at St. 171.

240. **Verneuilina minuta**, Wiesner (Plate V, figs. 22–26).

Verneuilina minuta, Wiesner, 1931, FDSE, p. 99, pl. xiii, fig. 155, pl. xxiii, Stereo-fig. *d*.

Thirty-two stations: 169, 171, 175, 177, 180, 181, 186, 191, 196–8, 203, 360, 363; 62° 50′ S, 60° 20′ 30″ W; WS 383–5, 395, 471, 472, 479, 480, 483–7, 494A, 498, 512, 515.

Widely distributed from the South Sandwich Islands to the Bellingshausen Sea, in depths between 160 and 3580 m. The only station at which it is common is St. 177 in the Bransfield Strait, 1080 m.; it is frequent at Sts. 196, WS 395 and 479; more or less rare elsewhere.

V. minuta is a very distinctive little species, distinguishable from *V. advena* by its somewhat larger size, its rough surface due to the small quantity of cement employed, and its regular conical outline. The last convolution is cut off abruptly, the chambers not being rounded off as in *V. advena*. The sutural lines are flush and obscure.

Wiesner's specimens were from 66° 2′ S, 89° 38′ E, 385 m. His description of the species is as follows: "Very small, with 4–5 convolutions, the arched chambers broader than high. Outer surface rough". He remarks that it is distinguishable from the related forms *V. polystropha* (= *V. scabra*, No. 237) and *V. advena* by its trifling size, and its solid regular form. Wiesner has been so good as to examine some of the Discovery specimens, and confirm their identification.

There is considerable variation in the size of the species at different stations. At Sts. 175 and 181 some specimens were found nearly double the general average, which is about 0·2 mm. long and 0·1 mm. greatest breadth. Long-narrow and short-broad forms also occur as in *V. scabra* and *V. advena*.

Genus **Gaudryina**, d'Orbigny, 1839

241. **Gaudryina bradyi**, Cushman (SG 161).

Five stations: 383, 385, 386; WS 400, 469.

Very rare everywhere; single specimens only except at St. 383, where several very large but thin-walled examples were found. All the stations are in the deep water of the Drake Strait, 3638–4773 m.

241 A. **Gaudryina flintii**, Cushman (SG 162).

One station: WS 505.

Frequent at St. WS 505 in the extreme south of the Bellingshausen Sea, off the ice barrier, depth 1500 m., where the specimens were large and well developed. It was not seen at any other station.

242. **Gaudryina deformis**, sp.n. (SG 163) (Plate V, figs. 37–40).

Seven stations: 383–5; WS 204, 403, 468, 469.

Test very irregular in outline, bluntly rounded at the apical end, which consists of about two or three sets of chambers arranged on a triserial plan. The biserial portion following consists of two or occasionally three pairs of chambers, often very ill-matched, so that the test becomes irregularly curved. Sutures vary from flush and almost invisible to deeply excavated. Chambers more or less inflated, the last pair usually abruptly truncated. Aperture small with a raised border. Shell wall thin, composed of very fine mineral grains without visible cement, smooth but not polished, fragile.

Length up to 0·90 mm.; greatest breadth at final chamber about 0·50 mm.

Not infrequent at Sts. 384 and WS 469, rare elsewhere. The test is apparently very fragile, as most specimens were more or less damaged. The early triserial portion is more frequently met with than adult shells, and only young individuals were found at Sts. WS 204 and 468. The young specimens might easily be mistaken for a *Verneuilina*.

This is a deep-water species, the records ranging between 3328 and 4344 m. It evidently belongs to the group of *Gaudryina baccata*, Schwager, and in some respects is suggestive of *G. uva*, Schwager (S. 1866, FKN, p. 201, pl. iv, figs. 13 *a*, *b*), generally regarded as a synonym of *G. baccata*. But it is altogether more irregular in its construction, in fact hardly any two specimens are alike.

I have again examined the single specimen which I recorded in the South Georgia report as *G. baccata* (SG 163). It is unquestionably *G. deformis*, and the report should be amended.

243. **Gaudryina apicularis**, Cushman (SG 164) (Plate V, figs. 35, 36).

Eight stations: 360, 362; WS 199, 203, 205, 469, 471, 472.

Rare or very rare everywhere, but many excellent specimens were found at Sts. 362, WS 471 and 472. All the stations are in the deep water of the Scotia Sea, between 3264 and 4259 m. It is a very widely distributed species, found in deep water in all the oceans, but does not appear to have established itself in the higher latitudes.

244. **Gaudryina minuta**, sp.n. (Plate V, figs. 45, 46).

Three stations: 360; WS 496, 497.

Test minute, consisting of a triserial portion nearly circular in section and occupying about half the length of the test, followed by a textularian series of several pairs of inflated chambers, steadily increasing in size and thickness, thus retaining the circular section. Early sutures flush, later ones depressed. Aperture a normal textularian slit on inner margin of final chamber. Constructed of fine mineral fragments without much cement; surface smooth, colour grey.

Length 0·25 mm.; maximum breadth and thickness 0·10 mm.

This very small species has all the characteristic features of the genus, and appears to be quite distinctive. Two specimens were found at St. WS 497 (534 m.), another at St. WS 496 (631 m.), both in the Bellingshausen Sea, and a single specimen at St. 360 in the Scotia Sea (3264 m.). Owing to its minute size and colour it may have been overlooked elsewhere.

245. **Gaudryina ferruginea**, Heron-Allen and Earland (Plate V, figs. 41–44).

Gaudryina ferruginea, Heron-Allen and Earland, 1922, TN, p. 123, pl. iv, figs. 13–15.

Three stations: 360, 383; WS 516.

Frequent at St. 360 in the Scotia Sea, 3264 m., otherwise extremely rare; a single specimen only at St. WS 516 in the Bellingshausen Sea, 2611 m., and several at St. 383 in the Drake Strait, 3744 m.

The species was originally recorded from 70 fathoms off the North Cape, New Zealand, where it is not uncommon, and its occurrence at such a distance, without intermediate records, is noteworthy. The Antarctic specimens agree in size and other respects with the types, the only difference being the use of finer sand particles in construction, giving a neater appearance to the test. This might be expected in deeper water. The characteristic deep ferruginous colour is constant in all localities. The size of the Discovery specimens agrees very well with those found by the 'Terra Nova'; about 0·35 mm. long, 0·15 mm. broad.

246. **Gaudryina pauperata**, sp.n. (Plate V, figs. 47–49).

Two stations: 169, 360.

Test minute, consisting of 2–3 sets of chambers arranged triserially, followed by 3–4 pairs of biserial chambers increasing rather quickly in size. Apex rounded; sutures depressed; chambers thick and rather inflated, giving a lobulate margin. Aperture normally textularian on the inner edge of final chamber. Walls thin and fragile, constructed of sand grains, rather coarse for the size of the organism, with a little grey cement. Colour dark grey.

Length 0·23 mm.; width 0·12 mm.; thickness 0·10 mm.

Very rare at both stations in the Scotia Sea, 2514–3264 m.; but the test is very fragile, and owing to its size and colour it would easily be overlooked.

Genus **Clavulina**, d'Orbigny, 1826

247. **Clavulina communis**, d'Orbigny (SG 165).

Twenty-three stations: 360, 373, 382–6; WS 199, 201, 203, 204, 377, 400, 403, 468, 469, 471, 472, 474, 495, 502, 517, 555.

Found in all areas in deep water between 2552 and 4773 m., and common at Sts. WS 199, 403, 474, 517 and 555. As usual, megalospheric specimens are most frequent. At some stations the megalospheric young in the triserial condition are abundant, and but for the presence of adult specimens might easily be mistaken for *Verneuilina* sp. The general type all over the region is very finely arenaceous, with a smooth, light grey test exhibiting no signs of segmentation externally, similar to those figured in the South Georgia report (pl. iii, figs. 39–42). The constituents are very minute, apparently Radiolarian and diatom debris.

At St. WS 474, and occasionally elsewhere, in addition to the smooth type, specimens occur in which the test is firmer through the presence of more cement, and the uniserial segments are distinct. At Sts. 385 and WS 204 a few young individuals in the triserial stage were found, very much larger than usual, and constructed of mineral grains of appreciable size. It is possible that they represent the young of another species of which no adult specimens were found.

Cushman, in his revision of some long-established genera, has made *C. communis* d'Orbigny the type of a new genus *Martinottiella* (C. 1925, etc., LFR, 1933, p. 37, pl. iv, figs. 6–8). I do not see the necessity for the distinction.

Sub-family *VALVULININAE*

Genus **Valvulina**, d'Orbigny, 1826

248. **Valvulina conica**, Parker and Jones (F 122).

Two stations: 360, 384.

Extremely rare at both stations.

249. **Valvulina fusca** (Williamson).

Rotalina fusca, Williamson, 1858, RFGB, p. 55, pl. v, figs. 114, 115.
Valvulina fusca, Brady, 1884, FC, p. 392, pl. xlix, figs. 13, 14.
Valvulina fusca, Cushman, 1918, etc., FAO, 1922, p. 63.

Seven stations: 383; WS 201, 400, 403, 468, 499, 517.

Family frequent at St. WS 517 in the Bellingshausen Sea, 2770 m.; very rare at the other stations.

Family BULIMINIDAE

Sub-family *BULIMININAE*

Genus **Buliminella**, Cushman, 1911

250. **Buliminella seminuda** (Terquem) (F 136) (SG 172).

Two stations: 175; WS 482.

Rare at both stations, which are in the Bransfield Strait, but the species is well represented at each by both long and short forms, the short predominating. Megalospheric specimens in plastogamic union were found at each station.

Note. The single plastogamic specimen found in the South Georgia area and regarded with suspicion as a "stray", may be accepted as local in view of these later discoveries. It was then incorrectly referred to and figured as *Bulimina elegantissima*, d'Orbigny, and the South Georgia report should be amended (SG 172 and pl. iii, fig. 47).

251. **Buliminella seminuda var. apiculata (Chapman).**

Bulimina elegantissima var. *apiculata*, Chapman, 1907, TFV, p. 31, pl. iv, fig. 77.
Bulimina elegantissima var. *apiculata*, Sidebottom, 1918, FECA, p. 123, pl. iii, fig. 11.
Buliminella spinigera, Chapman, 1918, etc., FAO, 1922, p. 113, pl. xxiii, figs. 1–4.

One station: WS 482.

A single specimen from 100 m. in the Bransfield Strait.

Genus **Robertina**, d'Orbigny, 1846

252. **Robertina arctica**, d'Orbigny (Plate V, figs. 52, 53).

Robertina arctica, d'Orbigny, 1846, FFV, p. 203, pl. xxi, figs. 37, 38.
Robertina arctica sub *Bulimina subteres*, Goës, 1894, ASF, p. 46.

One station: WS 496.

A single very good specimen from 631 m. in the Bellingshausen Sea. Although originally described and figured by d'Orbigny in his Tertiary of Vienna monograph, his types were not fossils but recent specimens from the North Cape and Siberia, and it has always been regarded as an Arctic species. Goës considers that it cannot be distinguished from *Bulimina subteres*, Brady, and suggests that d'Orbigny's name should have preference. But the figure (No. 453 out of the series 445–453 illustrating *Bulimina subteres*) which he selects as representing *Robertina arctica* is not particularly like d'Orbigny's figure.

253. **Robertina minutissima** (J. Wright) (F 133) (Plate V, figs. 50, 51).

One station: WS 514.

A typical specimen from St. WS 514 in the Bellingshausen Sea, depth 531 m., is a notable extension of the range of this tiny but very characteristic species, originally described from Ireland. A single specimen was also found in the Falklands area.

Genus **Bulimina**, d'Orbigny, 1826

254. **Bulimina pupoides**, d'Orbigny (F 123).

Four stations: 182, 202; WS 484, 515.

Very rare everywhere, and never quite typical.

255. **Bulimina elegans**, d'Orbigny (F 127) (SG 167).

Seven stations: 181, 186; WS 494A, 497, 509, 510, 512.

Confined to the Bransfield Strait, Palmer Archipelago and Bellingshausen Sea, where it is frequent at Sts. 181, 186, WS 510 and 512. Rarely more than a single specimen at the other stations.

256. Bulimina elongata, d'Orbigny.

Bulimina elongata, d'Orbigny, 1846, FFV, p. 187, pl. xi, figs. 19, 20.
Bulimina elongata, Brady, 1884, FC, p. 401, pl. li, fig. 1.

Three stations: 181, 196, 385.

Very rare at St. 181 in the Palmer Archipelago, depth 160–335 m. A single typical specimen at St. 196 in the South Shetlands, depth 720 m. At the remaining station, 385, which is in the Drake Strait, depth 3638 m., a few very small hyaline specimens were found.

257. Bulimina marginata, d'Orbigny (F 129) (SG 168).

Eight stations: 180, 202; 64° 56′ S, 64° 43′ W; WS 496, 497, 507A, 507B, 509.

The records are confined to the Bellingshausen Sea and depths between 435 and 631 m. It is frequent at Sts. WS 496, 497, 507A and 507B, and most typical at the last two of these stations. Elsewhere, specimens are usually weak in the development of the marginal cusps.

258. Bulimina patagonica, d'Orbigny (F 130) (SG 169).

Seventeen stations: 175, 177, 181, 186, 187, 194, 196; 64° 56′ S, 64° 43′ W; WS 383, 480, 483, 494A, 498, 511–14.

Confined to the South Shetlands, Bransfield Strait, Palmer Archipelago and Bellingshausen Sea. The only station where it is common is St. WS 511, where the specimens are rather weak. At Sts. 177, 181, 186 it is frequent and the specimens are large, with a tendency to run into *B. aculeata*. The first of these stations is in the Bransfield Strait, 1080 m., the others are in the Palmer Archipelago, 160–295 m. At most other stations the specimens are small and weak, though single large individuals were found at Sts. 175, 196 and WS 494A.

259. Bulimina aculeata, d'Orbigny (F 131) (SG 170).

Twenty-one stations: 180, 181, 196, 202, 203, 369, 386; WS 494A, 496–8, 505, 506, 507A, 507B, 509–14.

Common at Sts. WS 506, 507A, 507B; frequent at Sts. 181, 369, WS 496, 497, 498, 505, 511 and 512; rare or very rare elsewhere. The distribution is confined to the South Shetlands, Bransfield Strait, Palmer Archipelago and Bellingshausen Sea with the exception of two records. It is frequent at St. 369 in the South Sandwich Islands, 1767 m., and a single very small specimen was found at St. 386 in the Drake Strait, 4773 m. The depth at this last station is also exceptional, as the species is generally most frequent under 1000 m. The best specimens were found at St. 181 (160 m.) and at Sts. WS 506, 507A and 507B, all between 500 and 600 m.

At many stations, even where frequent, the specimens are weak, the species being feebly developed, and it is hard to discriminate between such specimens and *B. patagonica*. At St. 369, where the species is frequent, the smaller specimens are typical, but with increasing size, the marginal spines decrease, or even disappear entirely, leaving only the apical spine, which is often very large.

260. Bulimina inflata, Seguenza (F 132).

Two stations: 180; WS 517.

A single specimen at each station.

261. Bulimina buchiana, d'Orbigny (SG 173).

Six stations: 385–7; WS 204, 205, 469.

Rare at St. 386 and very rare elsewhere. All the stations are in the deep water of the Drake Strait and Scotia Sea, between 3102 and 4773 m.

Genus **Delosina**, Wiesner, 1931

Polymorphina? complexa, Sidebottom, 1904, etc., RFD, 1907, p. 16, pl. iv, figs. 1–9, text-figs. 3–7.

Delosina, nov. gen., Wiesner, 1931, FDSE, p. 123.

When Sidebottom first described *P.? complexa* he was "much puzzled as regards the genus of this species", a feeling which has been shared by all workers who have met with the form in subsequent years. He corresponded with me at intervals on its affinities, and in 1922 was definitely contemplating a paper establishing a new genus, *Delosina*, for its reception. His chief difficulty lay in the material available. Specimens were few in number, they were too small and thin-walled to section, and owing to some qualities inherent in the material of the test, *Polymorphina complexa* does not make good transparent preparations. For such a thin-walled test balsam preparations are very opaque and difficult to resolve. I think these factors even more than advancing years caused him to abandon the project, for in February, 1923, he wrote: "I shall not bother about *P. complexa*, and shall send you the slides of a paper I had thought of publishing. You can do what you like with them". The "paper" had got no farther than a record of published references, and as the slides threw no additional light on the subject, they were placed in the Heron-Allen and Earland collection, to await the time when more material should be available.

In subsequent years no attempt has been made to settle the systematic position of *P. complexa*. Cushman and Ozawa did not include it in their revision of the genus *Polymorphina*, merely stating (C. and O. 1930, P, p. 16) that "it has the same arrangement of chambers as *Guttulina*, but it has pores along the suture lines, and the aperture is quite different from any genus of the family. It may be a new genus belonging to some other family".

Wiesner found specimens in material from the "Winter Station" of the German South Pole Expedition, and in 1931 by a happy coincidence established the new genus *Delosina* for his organisms, using the name Sidebottom had chosen and for the same reason, Delos being the first recorded locality. Wiesner figures two distinct forms, both ascribed to Sidebottom's species, which he differentiates as "slender" and "broad", and gives no definition of his genus, stating only that "The slender shells are like those of *Polymorphina*, the broad ones sometimes have the chambers most irregularly assembled. The needle-stitch-like apertures are sometimes situated at the aperture surface of the chambers, sometimes on the sutures. The last of these apertures (i.e. *those on the* *sutures*, A.E.) do not open directly into the chambers, but generally into a canal running under the suture". Of the species he writes: "According to Sidebottom the apertures are sieve-like on the apertural surface. He does not mention the rows of pores on the sutures. Our specimens on the other hand have merely single pores on the apertural face, and also at other points on the chambers, which at the sutures form into rows". Wiesner's great contribution therefore is the information that a canal underlies the suture, and that the rows of pores which Sidebottom and Heron-Allen and Earland had figured opened into this canal, the existence of which had not previously been suspected.

Through the kind offices of Herr Wiesner, Professor A. Schellenberg of the Zoological Museum, Berlin University, has allowed me to examine the stock of specimens of *Delosina* collected at the Winter Station of the 'Gauss'. The majority of the specimens are of Wiesner's "broad" form (*D. wiesneri*, No. 266) which is the commoner species in the Kaiser Wilhelm's Land area, and they attain a larger size and greater variety of construction than would be imagined from the few specimens obtained from the Discovery material. There was also a single specimen of the "slender" form (*D. sutilis*, No. 265) which appears to be very rare, and another specimen of *D. complexa* (No. 262), *sensu stricto*. The chief value of the material to me was that Wiesner's canal system and its branches, the "stitches", could be distinctly seen in fragments of dead shells. I had been unable to see it in the Discovery material, except for the brief interval during which the canal becomes visible as an air-filled tube when specimens are immersed in fluid. It vanishes as soon as the fluid has expelled the air, and it is hardly visible in my sections, possibly because they are not thin enough.

The three forms found by the 'Gauss' are all present in the Discovery material but in different proportions, the "slender" form *D. sutilis* occurring with some frequency, the others being very rare. Before Wiesner's work came into my hands I had already succeeded in grinding sections of *D. sutilis*, the greater size and thickness of the shell enabling me to succeed where Sidebottom had failed with the smaller Mediterranean specimens. The sections did not add a great deal to the sum of knowledge, but the following points were made out:

(i) The great majority of the specimens are megalospheric, the megalosphere being very large and pear-shaped.

(ii) In one section the megalosphere has a loop-shaped aperture at its inner or narrow end, communicating with the second chamber. It is strongly suggestive of a Bulimine aperture.

(iii) Otherwise, there is no direct communication between the successive chambers, other than through the fine tubules in the walls.

(iv) There is no general aperture on the final chamber. The coarse perforations of the sieve figured on the apertural face of the final chamber by Sidebottom, and by Heron-Allen and Earland, do not penetrate through the shell wall. They appear to be short branching canals in the thickness of the wall, which is evidently spongy in this area, and to be the termination of the Wiesner canal underlying the suture.

(v) The Wiesner canals are not clearly visible in the sections, probably because the sections are too thick. Of their existence there can be no doubt, at least in *D. sutilis* and *D. wiesneri*; probably also in the other species.

(vi) The protoplasmic body is very voluminous. In specimens taken out of spirit and dried for sectioning it occupies and almost fills every chamber. It is very clear and free from inclusions of any kind and pink in colour.

From the foregoing observations it is evident that in *Delosina* any interchange of protoplasm between the different chambers, and between the interior and exterior of the shell, can only be effected via the tubuli, which are minute. It follows that all food must be digested and assimilated outside the test by the extruded protoplasm. This would account for the absence of stercomes in the internal protoplasm. The functions of the canals are entirely mysterious, but they may perhaps act as a circulatory system for water. They can hardly have any advantage over the tubuli as exits for the protoplasm, as the canals though of greater diameter than each tubule are few, while the tubules are infinite in number.

I am still almost as uncertain as hitherto with regard to the proper systematic position of *Delosina*. The single instance in which a Bulimine aperture has been seen is the only fresh evidence of possible affinities, and on that account I am transferring *Delosina* to the Buliminidae, but without any definite conviction that the genus will remain there. Neither Cushman nor Galloway in their recent systematic publications have found a resting place for *Delosina*. It has no very apparent connection with any other genus; though externally resembling both *Bulimina* and *Polymorphina*, its points of difference exceed those of resemblance. The sieve-like apertural face suggests *Pegidia* and *Sphaeridia* in the Pegididae, but there the resemblance ends. The canal system appears to be unique. Finally, there is a peculiar quality in the material of which the test is constructed which appears to be distinctive. Although hyaline and perforate the shell substance has none of that glassy clearness which might be expected in a thin-walled form, but appears to have a granular basis. There is a certain opalescent density in even the smallest and thinnest specimens which marks them as different from other hyaline Foraminifera. I should not be surprised if future research removed the genus to a new family established for its reception.

Sidebottom figured several different organisms under the name *Polymorphina*? *complexa*, and described none of them. For purposes of future reference I have, by comparison of the original types and published drawings, separated the records into five species.

262. **Delosina complexa** (Sidebottom) (Plate V, fig. 16).

> *Polymorphina complexa*, Sidebottom, 1904, etc., RFD, 1907, p. 16, pl. iv, figs. 1–3, and text-fig. 6.
>
> ? *Polymorphina complexa*, Heron-Allen and Earland, 1914, etc., FKA, 1915, p. 673, pl. li, fig. 1.

Two stations: 175, 181.

Test hyaline, thin-walled, finely perforate, round or oval in section, tapering to each extremity, the aboral end more or less acutely pointed. Chambers few in number, long and embracing, three to a convolution, the final convolution occupying the greater part of the test. No visible apertures; a series of coarse perforations sometimes found on the extremity of the final chamber appears to be superficial. Sutural lines depressed, the marginal edge of each chamber slightly overlaps the previous chamber, giving the appearance of a covered canal, but none can be traced in transparent mounts.

This is the commonest species in the Mediterranean and is well illustrated by Sidebottom, whose figures show the overlapping of the sutural edges and the sieve-like perforations. It is like all the *Delosinae* very variable, but bears a general resemblance to a *Bulimina* of the group of *B. pyrula*—*B. affinis*. Its range probably extends to the Indo-Pacific region, as the first figure in the Kerimba monograph (*ut supra*) almost certainly represents this species. Unfortunately the Kerimba specimens have been ruined by damp, so it is impossible to confirm the identity.

Delosina complexa is extremely rare in the Antarctic, two specimens were found at St. 175 in the Bransfield Strait, and another at St. 181 in the Palmer Archipelago. Wiesner also found it at Kaiser Wilhelm's Land. The specimens are all of the average size of the Delos types, and very small compared with the local species *D. sutilis*. They show no signs of the "stitches" in the sutures which mark that species. The largest specimen is 0·45 mm. long and 0·25 mm. broad.

263. Delosina complanata, sp.n. (F 293).

Polymorphina complexa, Sidebottom, 1904, etc., RFD, 1907, p. 10, pl. iv, figs. 4, 8, (?) 9.
Polymorphina complexa, Heron-Allen and Earland, 1916, FSC, p. 48, pl. viii, figs. 5–7.
Polymorphina complexa, Heron-Allen and Earland, 1932, F, No. 293.

The general characters of the species are similar to those of *D. complexa*, but the chambers which are at first triserial rapidly become biserial and opposed, giving a compressed appearance to the test. The ratio of length to breadth varies greatly in different specimens, in some instances the last pair of chambers embraces quite four-fifths of the entire test, giving a quadrate appearance to the specimen. Sidebottom's fig. 8 illustrates an extreme instance of this form, but he does not figure the other extreme of variation in which the test is elongate with almost parallel sides. I think his fig. 9 represents an abnormal specimen of this species. In general appearance the test resembles a *Polymorphina* of the group of *P. lingua* (= *P. compressa*), and is equally variable.

In the Mediterranean the species occurs with *Delosina complexa*, and with about equal frequency or rarity, for specimens are always uncommon. A single excellent specimen from South Cornwall, and the Discovery specimens (F 293) from off Cape Horn which are all referable to *D. complanata*, show that the species has a wide range, but so far it has not been found in the Antarctic.

264. Delosina polymorphinoides, sp.n.

Polymorphina complexa, Sidebottom, 1904, etc., RFD, 1907, p. 10, pl. iv, figs. 5–7 and text-fig. 7.
? *Polymorphina complexa*, Heron-Allen and Earland, 1914, etc., FKA, 1915, p. 673, pl. li, figs. 2, 3.
Polymorphina complexa, Sidebottom, 1918, FECA, p. 145, pl. v, figs. 13, 14.

The general characters of the species are those of *D. complexa*, but the chambers are more inflated, and the sutural lines are generally marked by a series of punctae which are apparently superficial and not apertures in the real sense, though if a canal exists along the sutural line (which is probable although I have not been able to confirm its existence) they would communicate with it. The chambers are arranged triserially, and the initial end is usually more or less acutely pointed, as in the figured specimen from Australia (*ut supra*), but sometimes bluntly rounded as in Sidebottom's fig. 5. These differences probably mark the microspheric and megalospheric forms respectively. The test bears a general resemblance to a *Polymorphina* of the group of *P. communis*.

The known distribution of the species—Mediterranean, East Africa, East coast of Australia—shows that this species has a wide range outside the Antarctic.

265. **Delosina sutilis**, sp.n. (Plate V, figs. 1–8).

Delosina complexa (slender form), Wiesner (*non* Sidebottom), 1931, FDSE, p. 123, pl. xxi, fig. 254.

Four stations: 170, 175, 363; WS 482.

Test hyaline, thick-walled and finely perforate; ovate, bluntly rounded at the initial extremity in the megalospheric form, the megalosphere being large and prominent; abruptly pointed in the microspheric form; rounded in both forms at the terminal end. The broadest point of the test is at about three-quarter length, in section it is nearly circular at first, becoming oval with growth. The test consists of few chambers, up to ten in number, arranged triserially with an increasing tendency to a biserial plan. Chambers inflated, elongate, embracing, increasing rapidly in size, the last two or three forming the bulk of the test. Sutures depressed, the marginal edge of each chamber slightly overlapping the edge of its predecessor. Parallel with the suture a line is visible along the edge of each chamber which marks a canal in the thickness of the shell. From the canal a number of short tubes extend to the edge of the overlap, where they terminate in minute openings. These short tubes have the appearance of stitches sewing the two chambers together. The terminal extremity of the shell bears a number of coarse punctae like a sieve; they are only superficial and do not pass through the wall; the canal appears to terminate in this sieve-like area, which represents the only approach to a general aperture in the test. The test is smooth and highly polished, of the colour of old ivory, sometimes with a pink tinge due to the underlying protoplasm, which in life fills all the chambers and is pink in colour and quite devoid of stercomes or digestion products.

Length of megalospheric specimens ranges up to 1·1 mm.; breadth up to 0·75 m.; thickness about 0·6 mm. A microspheric specimen was 1·20 mm. long, 0·85 mm. in greatest breadth.

The distribution is confined to St. 363 in the South Sandwich Islands, where only two specimens were seen, St. 170, off Clarence Island where many specimens were obtained, and Sts. 175 and WS 482 in the Bransfield Strait, where the species was less frequent than at St. 170. The maximum depth was 342 m. at St. 170. *Delosina wiesneri* occurred in company with *D. sutilis* except at St. 175, but always very rarely. In the Gauss material the frequencies are reversed, *D. wiesneri* being numerous and *D. sutilis* very rare.

D. sutilis[1] is outstanding in the genus owing to its comparatively large size, thick shell wall and elaborate canal system. It is probable that a similar canal system exists in all the species—it certainly does in *D. wiesneri*—but owing to the thinness of the wall of the test in the three Mediterranean species figured by Sidebottom (Nos. 262–4) it will be difficult to demonstrate its existence.

266. **Delosina wiesneri**, sp.n. (Plate V, figs. 9–15).

Delosina complexa, "broad form", Wiesner (*non* Sidebottom), 1931, FDSE, p. 123, pl. xxi, figs. 255–6.

Three stations: 170, 363; WS 482.

Test hyaline, thick-walled and finely perforate; subglobular in the megalospheric form, the megalosphere being prominent, though smaller than in *D. sutilis*. In the microspheric form the dorsal side rises in a steep cone to a blunt point. In both forms the ventral side is flattened. Chambers up to 8–10 in number, arranged triserially, sometimes biserial in the final convolution; inflated, increasing rapidly in size and nearly enveloping the early growth; all chambers visible on dorsal side, those of the last convolution only on the ventral side. Sutures nearly flush, marginal edge of each chamber overlapping its predecessor as in *D. sutilis*. The canal and its branches or "stitches" are visible only on the ventral side of the Discovery specimens, but can be temporarily demonstrated elsewhere by immersing the specimen in fluid. In the specimens from the 'Gauss', which are larger and more varied in build, both the canal and the "stitches" can be seen on other parts of the test, but they are less conspicuous than in *D. sutilis*. There does not appear to be any sieve-like area on the terminal face as in *D. sutilis*, but there are occasional larger punctae scattered over the surface of the chambers in some of the Gauss specimens, which may be homologous. The test is smooth but less highly polished than in *D. sutilis*, and the colour is less pronounced.

Height of megalospheric form about 0·45 mm.; of microspheric about 0·6 mm.; breadth of megalospheric varies between 0·40–0·55 mm.; of microspheric about 0·55 mm.

D. wiesneri is very rare in the Discovery material compared with *D. sutilis*; in the Gauss material conditions are reversed. Two specimens were found at St. 363 in the South Sandwich Islands, and two at St. 170, Clarence Island; a single specimen only at St. WS 482.

Genus **Virgulina**, d'Orbigny, 1826

267. **Virgulina squammosa**, d'Orbigny.

Virgulina squammosa, d'Orbigny, 1826, TMC, p. 267, No. 1; Modèle No. 64.
Virgulina squamosa, Brady, 1884, FC, p. 415.
Virgulina squammosa, Cushman, 1925, etc., LFR, 1932, p. 15, pl. iii, fig. 1.
Virgulina squamosa, Macfadyen, 1931, MES, p. 56, pl. i, fig. 23.

Seven stations: 167, 194, 196; Port Lockroy; WS 476, 482, 486.

Very rare everywhere except at St. 167, where it is not uncommon. The specimens are small and not very satisfactory.

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[1] *sūtĭlĭs*=stitched together.

268. **Virgulina bradyi**, Cushman (F 141) (SG 176).

Fifty-eight stations: 170, 175, 177, 180–2, 186, 187, 190, 194–6, 200, 202–4, 206, 363, 366, 369; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; WS 382–4, 386, 391, 393–6, 399, 476, 480–90, 493, 494A, 494B, 496–8, 507A, 509–15.

Frequent to common at most stations, and very common at Sts. 181, WS 511, 512. The depths run down to 2085 m., but there seems little connection between depth and frequency in this species.

269. **Virgulina schreibersiana**, Czjzek (F 138) (SG 174).

Thirty-eight stations: 162, 164, 167, 170, 175, 186, 187, 190, 192, 195–7, 200, 202, 209; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; WS 204, 205, 383, 387, 393, 395, 403, 468, 469, 476, 481, 482, 485–8, 493, 507B, 509, 512, 515.

Very common at St. 195; common at Sts. 162, 187, WS 395, 487 and 488; more or less rare at the remaining stations, which range down to 4344 m. As a rule the species is extremely rare at the deep-water stations, an exception being St. WS 403, where it is frequent in 3721 m.

270. **Virgulina schreibersiana var. complanata**, Egger (Plate V, figs. 54, 55).

Virgulina schreibersiana var. *complanata*, Egger, 1893, FG, p. 292, pl. viii, figs. 91, 92. (*Virgulina compressa* on p. 283, explanation of plate.)
Virgulina schreibersiana, Sidebottom (*non* Czjzek), 1918, FECA, p. 125, pl. iii, fig. 16.
Virgulina schreibersiana var. *complanata*, Cushman, 1925, etc., LFR, 1932, p. 11, pl. ii, fig. 6.

Seventeen stations: 187, 195, 196, 203, 369, 384–6; WS 403, 468, 481, 482, 505, 506, 507A, 507B, 511.

This elegant form is common at St. WS 403 and frequent at Sts. 384, 385 and 386, all of which are in the deep water of the Drake Strait and Scotia Sea, 3638–4773 m. It is also frequent at Sts. WS 505 and 507B in the Bellingshausen Sea, 580–1500 m. At the remaining stations, with depths ranging between 100 and 4344 m., it is very rare but typical. Many specimens exhibit a strong spiral twist in the long axis. The records of Egger and Sidebottom from the west and east coasts of Australia, depths 359 m. and 465 fathoms respectively, appear to be the only occasions on which this form has been recorded, and its appearance in Discovery material shows a notable extension of range.

Egger had called his variety *V. compressa* in the description of pl. viii on p. 283. Fortunately this specific name was anticipated by Bailey (*Bulimina* (= *Virgulina*) *compressa*, Bailey, 1851, SAC, p. 12, pl. O, figs. 35, 37), so the question of priority does not arise between Egger's two names.

V. schreibersiana var. *complanata* varies greatly in size. It may attain a length of 0·6 mm., with maximum breadth 0·1 mm.

271. **Virgulina subdepressa**, Brady (Plate VI, figs. 1–4).

Virgulina subdepressa, Brady, 1884, FC, p. 416, pl. lii, figs. 14–17.
Virgulina subdepressa, Egger, 1893, FG, p. 291, pl. viii, fig. 103.
Virgulina subdepressa, Cushman, 1925, etc., LFR, 1932, p. 10, pl. ii, fig. 4.

Two stations: 385, 386.

Very rare, but a few excellent specimens both megalospheric and microspheric were found at St. 386; two megalospheric specimens at St. 385. Both stations are in the deep water of the Drake Strait, 3638–4773 m.

Genus Bolivina, d'Orbigny, 1839

272. **Bolivina punctata**, d'Orbigny (F 143) (SG 177) (Plate VI, figs. 5–7).

Forty-five stations: 164, 171, 180, 181, 186, 190, 192, 195–9, 202, 203, 206, 366, 384–6; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; WS 204, 382–5, 391, 395, 396, 403, 471, 476, 479, 480, 482–7, 493, 494A, 509, 512, 513.

Generally distributed, but varying greatly in numbers. It is very common at Sts. WS 395, 485 and 487; common at Sts. 192, 196, 62° 57′ S, 60° 20′ W, and WS 486; frequent at Sts. 195, 202, 203, 385, 386, WS 383, 384 and 483. All these stations are in less than 1000 m., except Sts. 385 and 386, which are in the deep water of the Drake Strait, over 3600 m. At the remaining stations the species is rare or very rare, and sometimes represented by a single specimen. Their depths range between 24 m. at St. 164 (a single specimen) and 3762 m. at St. WS 471 (also a single pauperate specimen), but the majority are under 1000 m. Where the species occurs in any numbers both microspheric and megalospheric specimens are found, the megalospheric predominating greatly in numbers and being the only representative of the form at the stations where the species is rare. There is no doubt that the species is trimorphic; although time has not permitted of exact measurements there is a very noticeable difference in the size of the megalosphere at various stations.

A very curious pauperate(?) form occurs at several stations; in company with the ordinary type at Sts. 171, 195, 203, WS 385, 483 and 485, by itself at Sts. 198 and WS 471. These stations cover almost the entire range of depth. In these specimens the upper half of each chamber becomes so thin as to be iridescent and in many instances is entirely wanting, the test then showing an outline of sharp cusps. I think the fact that the pauperate specimens are usually found in company with the normal type is evidence that the formation is incidental to the gradual solution of dead shells, the thinner portion of the chamber being the first to disappear. On the other hand, it is rather singular that other species do not show a similar tendency to the dissolution of one portion of the test only.

273. **Bolivina textilarioides**, Reuss (F 144) (SG 178).

Eight stations: 164, 190, 195, 199, 366; Port Lockroy; WS 490, 512.

Extremely rare, never more than one or two specimens at each station, and all very pauperate.

274. **Bolivina spinescens**, Cushman (F 145) (Plate VI, figs. 8–10).

Four stations: WS 505, 506, 507A, 507B.

A single microspheric specimen at St. WS 505, rare at the other stations, where both megalospheric and microspheric specimens were found, very finely developed, the spines sometimes attaining considerable length. All the stations are in the far south of the Bellingshausen Sea, depths 572–1500 m. This is a Pacific species, but was recorded by the 'Terra Nova' from the Ross Sea.

275. **Bolivina robusta**, Brady (F 146) (SG 179).

One station: 180.

Very rare but typical at 160 m. in the Palmer Archipelago.

276. **Bolivina compacta**, Sidebottom (F 147).

One station: WS 482.

Only a single specimen from 50 m. in the Bransfield Strait.

277. **Bolivina difformis** (Williamson) (F 149) (SG 181).

One station: 386.

A single typical specimen at St. 386 in the Drake Strait, at the exceptional depth of 4773 m.

278. **Bolivina malovensis**, Heron-Allen and Earland (F 153) (SG 182).

Three stations: 385; WS 204, 205.

Rare at St. WS 204 and very rare elsewhere. All the stations are in deep water, 3328–4207 m.

279. **Bolivina inflata**, Heron-Allen and Earland (F 152).

One station: WS 482.

A single specimen from 50 m. in the Bransfield Strait.

280. **Bolivina cincta**, Heron-Allen and Earland (F 154) (SG 183).

Seven stations: 385, 386; WS 205, 468, 469, 505, 506.

Common at St. WS 505, frequent at Sts. 386 and WS 506, very rare elsewhere. The distribution is rather curious, as all the stations except WS 505 and 506 are outside, or just within, the Antarctic convergence line, and in very deep water, over 3600 m. Sts. WS 505, 506 are in the extreme south of the Bellingshausen Sea in depths of 1500 and 584 m. respectively.

281. **Bolivina decussata**, Brady (SG 184).

Three stations: 385, 387; WS 505.

A single typical specimen at each station. The two Discovery stations, 385 and 387, are in the deep water of the Drake Strait, depth 3638 and 3102 m. respectively, and the presence of a truly Pacific species there is not unexpected. But the third station, WS 505, is one of the most southerly soundings received. It lies in the south of the Bellingshausen Sea (70° 10′ 30″ S, 87° 46′ W), and the presence of *B. decussata* may perhaps be taken as evidence of the influence of a Pacific current extending into this truly Antarctic area.

Sub-family *CASSIDULININAE*

Genus **Pseudobulimina**, gen.n.

Test free, hyaline, consisting of two series of chambers of very different dimensions, rapidly increasing in size and arranged side by side in a helicoid spiral of rather more than one convolution. For convenience of description the outer large series will be called *A*, and the inner smaller series *B*. On the dorsal side, or viewed from one edge, both *A* and *B* are visible, *A* occupying most of the field of view. Seen from the other edge *A* only is seen. On the ventral side only *A* and the final chamber of *B* are exposed. The apertural face is very large and flattened, occupying nearly half of the ventral view. At least seven-eighths of its area represents the final chamber of *A*; a small triangle on its inner edge shows the final chamber of *B*. *A* is divided by a deep cleft running from its inner edge well into the middle of the apertural face; the walls of the cleft extend inwards and are connected to the apertural face of *A*'s previous chamber. The cleft does not open into the cavity of *A*'s chamber at all, the real aperture being an inconspicuous arch on the inner edge of the face, just over the exposed portion of *B*. *B* has no external aperture but is connected by an internal tube with the side of the cleft in *A*. This and much of the structure is only visible in balsam-mounted specimens.

Viewed as an opaque object the apertural face of *Pseudobulimina* is that of a typical *Ceratobulimina*; the exposed portion of *B* is so small that it might be overlooked. Viewed from the dorsal side or from one edge the two series of chambers are conspicuous.

The genus is based on the specimens discovered first by Chapman and subsequently by Heron-Allen and Earland in the Ross Sea, and referred by both to *Bulimina*. The similarity in external form to *B. contraria* (Reuss) was observed by both authors, but the biserial arrangement of chambers in their specimens excluded that species from consideration. *B. contraria* had been made the genotype of *Ceratobulimina* by Toula in 1915, and many species have since been described, mostly fossils. The Antarctic specimens are so like *Ceratobulimina*, except in the possession of the second series of chambers, that I was at first inclined to regard these as of little importance, and likely to exist in some of the described species of that genus. But after a careful examination of all the species to be obtained, for many of which I have to thank Mr W. J. Parr of Melbourne, and Mrs H. J. Plummer of Austin, Texas, I have been unable to find any with even a vestigial trace of the second series. Dr Cushman also informs me that he has never seen a second series in *Ceratobulimina*.

282. Pseudobulimina chapmani (Heron-Allen and Earland) (Plate VI, figs. 11–14).

Bulimina seminuda, Chapman (*non* Terquem), 1914, EDRS, p. 29, pl. ii, fig. 9 and p. 43, pl. v, fig. 6.
Bulimina chapmani, Heron-Allen and Earland, 1922, TN, p. 130, pl. iv, figs. 18–20.
Robertina chapmani, Wiesner, 1931, FDSE, p. 124, pl. xx, fig. 239.

Six stations: 170, 175, 181, 190, 363; WS 482.

Not infrequent at Sts. 170 and WS 482, rare elsewhere. Most of the specimens are in perfect condition, and it was possible to make balsam preparations which disclosed the internal structure.

The stations are strung out in a line from St. 363 in the South Sandwich Islands, through St. 170 off Clarence Island to the Bransfield Strait and Palmer Archipelago, depths ranging between 93 and 342 m. Chapman's specimens were from an elevated deposit probably laid down in over 100 fathoms; the Terra Nova specimens from depths down to 300 fathoms in the Ross Sea; Wiesner's from Kaiser Wilhelm's Land, 380–385 m. There are no other records yet, but I hear from Mr W. J. Parr that it is common in some of Sir Douglas Mawson's material and he has been so good as to send me specimens for comparison. They are smaller than the Discovery examples.

Genus **Cassidulina**, d'Orbigny, 1826

283. **Cassidulina laevigata**, d'Orbigny (F 157) (SG 185).

Eleven stations: 177, 180, 181, 196, 363, 386; WS 204, 469, 506, 507A, 507B.

Except at St. WS 204, where it is frequent but very small, this universally distributed species is extraordinarily rare, often represented by a single specimen only. The few stations at which it occurs are, however, distributed all over the area, and range between 160 and 4773 m. All the specimens are typical, though varying greatly in size, the best and largest at Sts. 177 and 363.

284. **Cassidulina pulchella**, d'Orbigny (F 158) (SG 187).

Three stations: 196; WS 204, 205.

Frequent at St. WS 204, which is in the deep water of the Scotia Sea, depth 3328 m. Very rare at the other stations. All the specimens were small.

285. **Cassidulina lens**, sp.n. (Plate VI, figs. 17–20).

One station: 363.

Test nearly circular, highly biconvex, with broadly rounded unbroken peripheral edge. Five pairs of straight-sided chambers are exposed on each face, but are very indistinct except in young shells or balsam-mounted specimens, owing to the smooth surface of the test, the sutural lines being absolutely flush. Aperture rather small but normal, with incurved edges. Walls thin, distinctly perforate, very smooth, glassy when young, becoming polished white and opaque in large or dead shells, and then showing no external signs of structure.

Diameter up to 0·50 mm.; thickness about 0·30 mm.

Not uncommon in 329 m. off Zavodovski Island in the South Sandwich Islands, but not seen elsewhere. It is a very distinctive form in the unbroken smoothness of its outline and surface.

286. **Cassidulina crassa**, d'Orbigny (F 160) (SG 188).

Forty-three stations: 162, 164, 167, 170, 175, 177, 180, 181, 186, 195, 196, 200, 201–3, 363, 366, 383–7; Port Lockroy; WS 204, 205, 383, 385, 389, 393, 469, 471, 474, 476, 481–3, 485–7, 506, 507A, 507B, 552.

Generally distributed over the entire area, but, except at a few stations, never a dominant species. In the Weddell Sea and South Sandwich area it is frequent at St. 363, rare or very rare elsewhere, and always a small or very small type. In the South Orkneys area it is very common and large at St. 167; common but small only at Sts. 162 and 201; common also, but both large and small, at St. 170; very rare and small at the remaining stations. In the Bransfield Strait and South Shetlands area it is very common, both large and small types at Sts. 195 and WS 482; common and large at St. 175; common and small at St. WS 383; frequent to very rare and always small at the remaining stations. In the deep-water stations of the Drake Strait and Scotia Sea, and in the Bellingshausen Sea it is usually small and very rare, though there are exceptions, it being frequent though small at St. WS 507A, while a few large specimens were found at St. 386 in 4773 m. As a general rule the large form is not found at greater depths than 400 m.

At St. 167 in the South Orkneys, where the species is very common at 244 m., two abnormal specimens were found, one consisted of three medium-sized individuals fused together; in the other case a large individual had suffered fracture and loss of the final chambers, and had repaired the damage with a terminal chamber and aperture set at right angles to the plane of growth. With these exceptions the species is remarkably true to type and free from abnormalities everywhere.

287. **Cassidulina crassa** var. **porrecta**, Heron-Allen and Earland (F 161).

Six stations: 167, 384, 385; WS 204, 469, 482.

Frequent at St. WS 469, very rare at the other stations. Four of the stations, 384, 385, WS 204 and 469, are in the very deep water of the Drake Strait, 3328–3959 m.; of the others, St. 167 is in 244 m. off the South Orkneys, and St. WS 482 is in 100 m. in the Bransfield Strait.

288. **Cassidulina subglobosa**, Brady (F 162) (SG 189) (Plate VI, figs. 21, 22).

Fifty-five stations: 163, 164, 167, 170, 175, 177, 180, 190, 192, 194–7, 199, 200–3, 363, 366, 383–6; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; Port Lockroy; WS 204, 205, 383, 385, 389, 391, 393, 395, 403, 468, 469, 474, 476, 479, 481–3, 485–7, 493, 494A, 496, 497, 505, 506, 507A, 507B, 511.

Generally distributed but usually more or less rare. It is, however, very common though small at St. 195 in 391 m.; large and common at St. 164 in 24 m.; common, both large and small, at St. WS 482 in 50–152 m. Excellent specimens are frequent at Sts. 170, 363 and 366, all of which are under 400 m. But depth does not appear to have much influence except in its greater rarity, for large and excellent specimens are found in the deepest water stations such as Sts. 383, 385, 386, though they are few in number. There is the usual range of variation in the rotundity of specimens, but as a general rule they are very typical and the flattened variety is less widely distributed than in the South Georgia area. At St. 383 two specimens were found in which the two final chambers, abandoning the coil system, were extended in a straight line, thus conforming with the plan of growth of *Cassidulinoides*. In the absence of further material I prefer to regard them as abnormal specimens of *C. subglobosa*.

289. **Cassidulina subglobosa** var. **tuberculata**, Heron-Allen and Earland (Plate VI, figs. 26, 27).

Cassidulina subglobosa var. *tuberculata*, Heron-Allen and Earland, 1922, TN, p. 138, pl. iv, figs. 36–8.
Cassidulina subglobosa var. *tuberculata*, Cushman, 1925, etc., LFR, 1925, p. 54, pl. viii, figs. 43–5.

One station: 170.

A single specimen from 342 m. at Clarence Island. The tubercles are smaller than in the types which were from 245–268 fathoms in the Ross Sea. I know of no subsequent record.

290. Cassidulina elegans, Sidebottom (Plate VI, figs. 15, 16).

Cassidulina elegans, Sidebottom, 1910, TNC, p. 106, pl. iv, fig. 1.
Cassidulina elegans, Cushman, 1910, etc., FNP, 1911, p. 99.

Three stations: 383, 384, 385.

A single typical specimen was found at each of the stations 383 and 384, and two weakly marked individuals at St. 385. All the stations are in the deep water of the Drake Strait, 3638–3744 m., but inside the convergence.

This is an essentially Pacific species, rare even in the few localities recorded. Sidebottom's specimens were from 1050 fathoms in the south-west tropical Pacific (19° 04′ S, 179° 43′ E), and Cushman's from the north Pacific between Japan and Guam, 891–1088 m. Its occurrence in such a distant area is very noteworthy.

291. Cassidulina pacifica, Cushman (Plate VI, figs. 23–25).

Cassidulina calabra, Brady (non *Burseolina calabra*, Seguenza, 1880), 1884, FC, p. 431, pl. cxiii, fig. 8.
Cassidulina calabra, Chapman, BL, p. 275.
Cassidulina calabra, Bagg, 1912, PPSC, p. 42, pl. xii, fig. 1.
Cassidulina calabra, Pearcey, 1914, SNA, p. 1016.
Cassidulina calabra, Sidebottom, 1918, FECA, p. 128, pl. iii, fig. 22.
Cassidulina calabra, Cushman, 1918, etc., FAO, 1922, p. 132.
Cassidulina calabra, Cushman, 1925, etc., LFR, 1925, p. 55.
Cassidulina pacifica, Cushman, 1925, etc., LFR, 1925, p. 53, pl. ix, figs. 14–16.

Two stations: 383, 384.

A few specimens only at each station. Both are in the deep water of the Drake Strait, over 3700 m. but inside the Antarctic convergence. The best specimens were found at St. 383.

It is impossible to reconcile the *C. calabra* of Brady with the figure and description of *Burseolina calabra*, Seguenza, in spite of the fact that Brady states that he had received from Seguenza specimens of his Miocene fossils, and that though their fossilized condition had rendered the septation more or less obscure, he had no doubt that they were identical in all important characters with the recent specimens which he figured.

Seguenza's specimens were apparently returned to him, as they are not to be found in the Brady collections either at Cambridge or in the British Museum. In these circumstances it would appear reasonable to adopt the name *Cassidulina pacifica*, Cushman, for the Challenger specimens figured by Brady.

All the records given for *C. calabra* above may be regarded as identifiable with Brady's type, as the two authors (Chapman and Pearcey) who did not figure their specimens would be familiar with the Challenger material. Pearcey's record (Scotia St. 346, near the Burdwood Bank, 56 fathoms, 54° 25′ S, 57° 32′ W) is of particular interest as approaching the Discovery localities. The other recent records are all in the Pacific and Indo-Pacific regions.

Genus **Cassidulinoides**, Cushman, 1927

292. **Cassidulinoides parkerianus** (Brady) (F 163) (SG 190).

Nineteen stations: 170, 175, 180, 181, 195, 196, 200, 201, 206, 363, 366; WS 382, 474, 476, 482, 488, 490, 493, 494A.

Generally distributed over the entire area, with the exception of the most southerly stations of the Bellingshausen Sea and the deep water of the Drake Strait and Scotia Sea. It is common and very well developed at St. 170 in 342 m. off Clarence Island; frequent and equally good specimens at Sts. WS 382 and 482 in the Bransfield Strait. Very good and typical specimens at Sts. 363 and 366 in the South Sandwich Islands, where it is rare. Rare to very rare at the remaining stations. It appears to be most at home at less depths than 500 m., there being few records over that depth, and only one in deep water, at St. WS 474, 2813 m., where it is very rare.

Genus **Ehrenbergina**, Reuss, 1850

293. **Ehrenbergina pupa** (d'Orbigny) (F 164) (SG 191).

Nine stations: 177, 196, 198, 200, 363, 387; WS 474, 482, 486.

Rare or very rare everywhere, except at St. 196 in the South Shetlands, depth 1011 m., where many specimens were observed. The stations, which are scattered over a large area in the South Sandwich Islands, Scotia Sea, Drake Strait, and Bransfield Strait, have a great range of depth between 50 and 3102 m., but all the specimens are of the short, subglobular type described in the Falklands report (F 164), and figured on pl. ix, figs. 41–3 in that report.

294. **Ehrenbergina bradyi**, Cushman (F 166) (SG 194).

Nine stations: 383–7; WS 204, 403, 468, 469.

Excellent specimens were frequent at Sts. 384, 385, 386 and WS 469, and frequent but smaller at St. WS 403; rare or very rare elsewhere. All the stations are in the deep water of the Drake Strait between 3102 and 4773 m., and several are outside the Antarctic convergence line.

295. **Ehrenbergina hystrix**, Brady (Plate VI, figs. 33–35).

Ehrenbergina hystrix, Brady, 1879, etc., RRC, 1881, p. 60; 1884, FC, p. 434, pl. lv, figs. 8–11.
Ehrenbergina hystrix, Cushman, 1910, etc., FNP, 1911, p. 102, fig. 156.
Ehrenbergina hystrix, Heron-Allen and Earland, 1922, TN, p. 140.
Ehrenbergina hystrix, Cushman, 1927, E, p. 3, pl. i, fig. 6.

Five stations: 383–6; WS 403.

Good specimens were frequent at St. 385, rare or very rare at the other stations. They are all in the deep water of the Drake Strait between 3638 and 4773 m. This is a Pacific species, and Cushman (1927, *supra*) says that its "known distribution is in the tropical Pacific from nearly 140° W to nearly 140° E, and extending barely beyond the Tropics. An exception to this are the specimens recorded by Heron-Allen and Earland from the Antarctic, south of New Zealand. The average of all known records gives about 2000 fathoms". The Discovery records are therefore of interest as marking an extension of regional distribution, St. 383, the most southerly limit, being in 60° 32′ S, 62° 42′ W. The Terra Nova specimens were from 66° 29′ 8″ S, 166° 8′ W, 1894 fathoms.

296. **Ehrenbergina hystrix** var. **glabra**, Heron-Allen and Earland (F 165) (SG 192).

Four stations: 386; WS 403, 505, 517.

Only a single specimen at each station, two of which are in the Drake Strait, and the others in the Bellingshausen Sea. Its rarity in this sector of the Antarctic is curious, when compared with the abundance of specimens observed at Terra Nova stations in the Ross Sea. Its absence from the South Shetlands and South Orkneys is also remarkable, as the variety was recorded from both the Falklands and South Georgia.

297. **Ehrenbergina crassa**, Heron-Allen and Earland (SG 193).

One station: 167.

A single megalospheric specimen was found at St. 167 in the South Orkneys. In view of the abundance of the species in South Georgia, I am inclined to the view that this specimen may be a stray, and that the species is confined to South Georgia. It has such a striking appearance that it could hardly have been overlooked if present in the Antarctic material.

298. **Ehrenbergina parva**, sp.n. (Plate VI, figs. 28–32).

Sixteen stations: 175, 180, 181, 186, 195, 196, 200, 202, 203, 209; WS 382, 393, 395, 476, 482, 487.

Test biserial, consisting of about 4–6 pairs of chambers rapidly increasing in size; commencing with a spiral curve and continuing growth in a straight line, presenting well-marked differences between the dorsal and ventral sides. Wall of the test rather thick, coarsely perforated, the perforations giving a granular appearance to the test. The chambers become increasingly inflated towards the aperture, which is a loop-like slit set obliquely on the inner face of the final chamber, but sometimes almost terminal. The sutural lines are depressed, particularly on the ventral side. On the dorsal side, which is flatter than the ventral, the sutural lines are distinct, but almost flush.

The aboral extremity of the shell displays a prominent knob on the ventral side of the test, which contains the earliest chambers. In the megalospheric form this knob is rounded and contains a large proloculus, under and behind which are the first pair of chambers, growth then continuing in a straight series of 3–4 pairs of chambers. In the microspheric form a very small proloculus is followed by a complete spiral curve of minute chambers, about three pairs, after which there is a rapid increase in size of the chambers of the straight series. The initial series forms a wedge-shaped protuberance on the ventral side of the microspheric shell.

In structure *E. parva* is almost identical with *E. crassa*, but presents well-marked distinctions. In size it is comparatively minute; there is no very great difference between the sizes of the megalospheric and microspheric forms as there is in *E. crassa*; the two forms are practically identical in number, whereas in *E. crassa* the microspheric form is comparatively rare; the proloculus in the megalospheric form is smaller in proportion to the size of the test, and never forms such a prominent feature as in *E. crassa*; finally the surface of the test is roughly granular on the exterior in contrast with the glassy smoothness of *E. crassa*. This distinction appears to be due to a difference in the diameter of the perforations in the two species.

Length: microspheric 0·30–0·50 mm., megalospheric 0·20–0·40 mm.; maximum breadth up to 0·20 mm.; thickness about 0·18 mm.

As compared with *E. crassa*

	Megalospheric	Microspheric
Length	0·70–1·08 mm.	0·90–1·35 mm.
Breadth	0·30 mm.	0·35 mm.
Thickness	0·25 mm.	0·30 mm.

E. parva appears to be confined to the Bransfield Strait, South Shetlands and Palmer Archipelago where it is found at moderate depths, 100–1000 m. Never common, it was found in some numbers at Sts. 175, 195, 196 and WS 482, elsewhere it was very rare, but owing to its small size may have been overlooked.

Family CHILOSTOMELLIDAE

Genus **Seabrookia**, Brady, 1890

299. **Seabrookia earlandi**, J. Wright (F 168) (SG 195).

One station: WS 403.

A single specimen from 3721 m. in the Drake Strait.

Family ELLIPSOIDINIDAE

Genus **Pleurostomella**, Reuss, 1860

300. **Pleurostomella subnodosa**, Reuss.

Nodosaria nodosa, Reuss (*non* d'Orbigny), 1845, VBK, pt. i, p. 28, pl. xiii, fig. 22.
Dentalina subnodosa, Reuss, 1851, FKL, p. 24, pl. i, fig. 9.
Pleurostomella subnodosa, Reuss, 1860, FWK, p. 204, pl. viii, fig. 2 *a*, *b*.
Pleurostomella subnodosa, Brady, 1884, FC, p. 412, pl. lii, figs. 12–13.
Pleurostomella subnodosa, Cushman, 1918, etc., FAO, 1922, p. 50.

Two stations: 384, 385.

A single specimen at each of these deep-water stations in the Drake Strait.

Family LAGENIDAE

Sub-family *LAGENINAE*

Genus **Lagena**, Walker and Boys, 1784

Note. For greater convenience the numerous species are arranged in alphabetical order.

301. **Lagena acuta** (Reuss) (F 211) (SG 196).

Eight stations: 363, 383–6; WS 403, 469, 481.

Curiously rare, never more than a few specimens at a station, and very variable. Nothing exactly resembling the type of Reuss occurs, but taking the species in a broad sense as a mucronate form of *L. biancae*, fairly typical specimens were found at Sts. 363, 384, 385 and WS 481. An inflated variety with hooded aperture similar to Sidebottom's figure (S. 1912, etc., LSP, 1913, p. 182, pl. xvi, fig. 7) was found at Sts. 383, WS 403,

469. At Sts. 383 and 386 an inflated but short-spined form resembling Cushman's figure (C. 1910, etc., FNP, 1913, p. 6, pl. xxxviii, fig. 6) occurs. This variety incidentally is much nearer to *L. sacculus*, Fornasini (*L. acuta*, Reuss var. *sacculus*, F. 1901, NNI, p. 49, fig. 3) than the specimens figured by Cushman (*ut supra*, p. 8, pl. iii, figs. 1–3) under that name. *Vide post* No. 370.

302. **Lagena acuticosta**, Reuss (F 196) (SG 197).

Twelve stations: 170, 175, 190, 383–6; WS 204, 205, 403, 469, 482.

Rare or very rare at all stations, but generally typical and well developed. The best and largest specimens at Sts. 175 and WS 482, both of which are in moderate depths. Some of the specimens at St. WS 482 have circular holes in the test, evidently bored by some other organism in search of food. At the deeper stations the specimens are generally small and variable.

303. **Lagena alveolata**, Brady.

Lagena alveolata, Brady, 1884, FC, p. 487, pl. lx, figs. 30, 32.
Lagena alveolata, Cushman, 1910, etc., FNP, 1913, p. 33, pl. xviii, fig. 1.
Lagena alveolata, Sidebottom, 1912, etc., LSP, 1912, p. 424, pl. xxi, figs. 1, 2; 1913, p. 202, pl. xviii, figs. 11, 12.

Five stations: 384, 385, 386; WS 468, 469.

The species is very rare and confined to deep-water stations in the Drake Strait, mostly outside the Antarctic convergence line. The depths range between 3638 and 4773 m. The specimens are variable and agree only in the possession of the four basal loops which mark the species. At St. WS 469 the single specimen is of the very distinctive form figured by Sidebottom (S. 1912, etc., LSP, 1912, p. 424, pl. xxi, fig. 2).

304. **Lagena alveolata var. caudigera**, Brady.

Lagena alveolata var. *caudigera*, Brady, 1884, FC, p. 488, pl. lx, fig. 25.
? *Lagena alveolata* var. *caudigera*, Sidebottom, 1912, etc., LSP, 1912, p. 424, pl. xxi, fig. 4.

One station: 386.

A single specimen only from 4773 m. in the Drake Strait, and outside the Antarctic convergence line. It differs from Brady's figure and description to some extent, having shorter basal spines and being devoid of the beaded lines near the base. Sidebottom's figure shows more numerous spines than Brady's or my specimens.

305. **Lagena alveolata var. separans**, Sidebottom (F 246).

Three stations: 201, 383, 386.

Extremely rare and very small compared with the specimens from the Falklands area. It is a Pacific form and did not figure in the South Georgia report. Two of the stations are in the Drake Strait, and the remaining St. 201 is in the Bransfield Strait, to which area the influence of Pacific water extends.

306. **Lagena alveolata var substriata**, Brady (SG 198).

Six stations: 384–6; WS 204, 403, 468.

This typically Pacific form occurs only at very deep-water stations in the Drake Strait and Scotia Sea, ranging between 3328 and 4773 m., but is frequent at St. 385, rare or very rare elsewhere. Two of the stations, 386 and WS 468, are outside the convergence.

Brady figures only a single specimen, in which the facial costae are confined to the regions of the neck and base, the central area being clear. But in his description he says that "the surface of the test is more or less costate or striate, especially near the base and apex". My material shows a complete range from faintly striate at St. WS 468 to strongly costate all over at St. WS 204. At Sts. 385 and WS 403 the full range of variation occurs. At the remaining stations the range is from faintly costate to the type as figured by Brady.

307. **Lagena ampulla-distoma**, Rymer Jones.

Lagena vulgaris var. *ampulla-distoma*, Rymer Jones, 1872, RFL, p. 63, pl. xix, fig. 52.
Lagena ampulla-distoma, Brady, 1884, FC, p. 458, pl. lvii, fig. 5.
Lagena ampulla-distoma, Millett, 1898, etc., FM, 1901, p. 5, pl. i, fig. 5.

One station: 385.

A single very large specimen from just inside the Antarctic convergence line. The surface granulation is much finer than is usually the case, otherwise it is quite typical. This is normally a warm water species of the Indo-Pacific region.

308. **Lagena apiculata** (Reuss) (F 174) (SG 200) (Plate VI, fig. 36).

Fifteen stations: 170, 175, 200, 385, 386; WS 204, 205, 382, 403, 468, 469, 472, 481, 482, 489.

Frequent and varied at St. 170, rare or very rare elsewhere. Practically all the variations referred to in the South Georgia report (SG 200) were observed. The large variety referred to in that report was recorded at Sts. 170, 175, 200, WS 382, 469 and 482, and at several of these stations was the sole representative of the species. At St. WS 468, in addition to typical specimens, two were found which have been assigned to this species with some doubt. They are cylindrical, rounded at both extremities and furnished with a prominent entosolenian tube, not attached to the side of the test. They might equally well be regarded as abnormally elongated *L. ovum*, or straight *L. botelliformis*.

309. **Lagena aspera**, Reuss (F 182) (Plate VI, figs. 37, 38).

Three stations: 383–5.

Very fine specimens were found at these three deep-water stations in the Drake Strait, inside the Antarctic convergence line. They are of a massive type as regards the construction of the test, which is globular and thick-walled, with a strong tapering neck about equal in length to the diameter of the body. The surface markings by contrast are weak, often strongest on the neck, while on the body they are mere rugosities, like the skin of an orange. Cushman figures a similar but rather coarser form from the Pacific (C. 1910, etc., FNP, 1913, p. 16, pl. xvi, fig. 1).

310. **Lagena auriculata**, Brady (F 245) (SG 201).

Six stations: 383–6; WS 204, 403.

Extremely rare and confined to the deepest water stations. Although only eight specimens in all were obtained, they represent four very different forms of this variable species. At St. WS 204 it is a simple non-carinate flask very like a figure by Sidebottom

(S. 1912, etc., LSP, 1912, pl. xx, fig. 9). At St. 386 the same form occurs in a trigonal variety. At Sts. 384, 385 and WS 403 a compressed and carinate form, with a long neck connected by a wing with the body of the shell, has auricles extending right across the base, rather like the specimen figured by Millett (M. 1898, etc., FM, 1901, p. 625, pl. xiv, fig. 15). A second specimen at St. 384 is entosolenian, cordate in form, broadest at the base, which is flattened, the auricles being indicated only by white patches contrasting with the glassy shell. And finally at St. 383 a very elongate specimen resembling another figure by Sidebottom (S. 1912, etc., LSP, 1913, pl. xvii, fig. 22). Its attribution to *L. auriculata* seems open to doubt. Sidebottom says that the "loops at the base are feebly represented". In his figure they appear to be external markings only, and they are such in my specimen.

311. **Lagena auriculata var. arcuata**, Sidebottom.

Lagena auriculata var. nov. *arcuata*, Sidebottom, 1912, etc., LSP, 1912, p. 421, pl. xx, figs. 19, 20; 1913, p. 200.

Two stations: 385; WS 204.

A single excellent specimen at St. 385 and two equally good at St. WS 204. Both stations are in deep water, 3638 and 3328 m. respectively, within but very near the Antarctic convergence line.

312. **Lagena auriculata var. costata**, Brady.

Lagena auriculata var. *costata*, Brady, 1879, etc., RRC, 1881, p. 61; 1884, FC, p. 487, pl. lx, fig. 38.
Lagena auriculata var. *costata*, Cushman, 1910, etc., FNP, 1913, p. 32, pl. xiv, fig. 2.
Lagena auriculata var. *costata*, Sidebottom, 1912, etc., LSP, 1912, p. 422, pl. xx, figs. 21, 22; 1913, p. 200.

One station: 385.

A single specimen from 3638 m. in the Drake Strait just inside the convergence. It is longer and more finely striate than Brady's type, and closely resembles Sidebottom's fig. 21 (*ut supra*).

313. **Lagena basireticulata**, sp.n. (Plate VI, figs. 39, 40).

Three stations: 384; WS 468, 469.

Test nearly globular, the upper half smooth and devoid of ornament, the lower half covered with strong costae which at the base merge and form strong hexagonal pits. Oral extremity obtuse and flattened with central aperture.

Length 0·3 mm.; breadth and thickness about the same.

Only a single specimen from each station, all of which are in deep water (4344–3713 m.) and on both sides of the Antarctic convergence line.

The species resembles *L. seminuda* in the hexagonal ornament of its basal portion, but has also the costae characteristic of *L. exsculpta*, which has no basal ornament.

314. **Lagena biancae** (Seguenza) (F 210) (SG 202).

Twenty-five stations: 170, 175, 192, 195, 196B, 198, 200, 363, 383–6; WS 204, 205, 384, 385, 403, 468, 469, 481, 482, 487, 498, 506, 507B.

This species is singularly rare as compared with its abundance in the Falklands area, and to a lesser extent in South Georgia. It is rare or very rare everywhere, except at St. 385 in 3638 m., where it was frequent and presented most of the variations referred to in the previous reports. Both long and short specimens were found at this station as well as the punctate varieties. At the deep-water stations 384, 385 and 386 specimens with rough exterior predominate, but this may be due to decomposition of the surface layer of the test. The finest and largest specimens were found in the South Orkneys, South Shetlands and Bransfield Strait. In the most southerly records at Sts. WS 506 and 507B, which are above 70° S, the species is very rare and small but quite typical, thus proving it to be truly cosmopolitan. A single trigonal specimen was found at St. WS 482. At Sts. 170, 386 and WS 468 a variety occurs with more or less strongly developed basal carina, the best development being at St. 386. It appears to be identical with *Fissurina ovata*, Seguenza (S. 1862, FMMM, p. 62, pl. ii, figs. 9, 10) but does not seem worth varietal separation. *Lagena cushmani*, Wiesner (see No. 365) (W. 1931, FDSE, p. 121, pl. xix, fig. 225), seems to be very similar, but perhaps more inflated and with a broader keel.

315. **Lagena bicarinata** (Terquem) (F 236) (SG 203).

Two stations: 385, 386.

Several specimens at St. 385, a single one only at St. 386. The stations are in very deep water, outside and just within the Antarctic convergence line.

316. **Lagena bisulcata**, Heron-Allen and Earland (F 239) (SG 204).

Three stations: 170, 175, 200.

Large and very typical specimens are not uncommon at St. 170. Very rare but equally good at the other stations.

317. **Lagena botelliformis**, Brady (F 173).

Four stations: 175, 385, 386; WS 204.

A single excellent specimen at St. 175, very rare and less typical at the other stations.

318. **Lagena catenulata**, Reuss (F 201) (SG 205).

Seven stations: 170, 200, 363, 384–6; WS 204.

Only single specimens except at Sts. 384 and 385 where it is very rare. The best and largest individuals were found in deep water at Sts. 384, 385 and 386.

319. **Lagena chasteri**, Millett.

Lagena chasteri, Millett, 1898, etc., FM, 1901, p. 11, pl. i, fig. 11.
Lagena chasteri, Sidebottom, 1912, etc., LSP, 1912, p. 398, pl. xvi, figs. 31–4; 1913, p. 180.

Three stations: 386; WS 505, 507B.

Very rare at all the stations, but quite typical at St. 386, which is in very deep water in the Drake Strait and outside the Antarctic convergence line. The specimens from Sts. WS 505 and 507B are in closer resemblance to Sidebottom's fig. 32 (*ut supra*); the surface texture being coarser. His description of the structure of the test does not appear to be correct. The shell wall is compound, the inner hyaline shell being covered with a dense pile of very fine hairs, the flattened ends of which constitute the smooth outer covering of the test. The "minute pores" to which Sidebottom refers are probably the spaces between the hairs when the outer layer has been broken. My specimens show all stages in the disintegration of this outer spongy layer.

Millett's species was originally described from shallow water in the Malay Archipelago, and I know of many records from shallow water in the Indo-Pacific region. Sidebottom records it from deep water in the south-west Pacific (*ut supra*), and from thence its passage to St. 386 can be directly connected with the Pacific current passing through the Drake Strait. But the occurrence of the species in genuinely Antarctic surroundings at St. WS 505 and WS 507B above 70° S latitude is somewhat surprising, and points to an influx of Pacific water into the Bellingshausen Sea.

320. **Lagena clathrata**, Brady (F 243) (SG 206).

One station: WS 205.

Only a single specimen, quite typical in form but with finer and more numerous costae across the face of the shell than is usually the case. The varieties found in the Falklands and South Georgia areas were not met with in the Antarctic material.

321. **Lagena clavata** (d'Orbigny) (F 178).

Two stations: 170; WS 482.

Only a single specimen at each station.

322. **Lagena clavulus**, Heron-Allen and Earland.

Lagena aspera var., Sidebottom, 1912, etc., LSP, 1913, p. 167, pl. xv, figs. 12, 13 (only).
Lagena clavulus, Heron-Allen and Earland, 1922, TN, p. 145, pl. v, fig. 7.

One station: 386.

A single specimen only from 4773 m. and outside the Antarctic convergence line. The original type, with which it conforms, was from 951 fathoms off Oates Land in the Ross Sea, but the specimens from the south-west Pacific (subtropical) figured by Sidebottom (*ut supra*) appear to be identical with our species.

323. **Lagena clowesiana**, nom.n. (Plate VI, figs. 41, 42).

Lagena semicostata, Sidebottom (*non* Seguenza), 1912, etc., LSP, 1912, p. 427, pl. xxi, fig. 13.

Three stations: 384, 385; WS 403.

Test compressed, irregularly ovate, wedge-shaped; central and upper portion of the test hyaline; fine, parallel costae encircle the sides and basal half of the test. At the base the two sets of curving costae are separated by a slight median bar.

Very rare. Two quite typical specimens at Sts. 385 and WS 403, and a good but worn example at St. 384. All the stations are in deep water in the Drake Strait and Scotia Sea, inside the Antarctic convergence line.

Sidebottom's species is quite distinctive in its markings. It was based on a single specimen from 1425 fathoms in the south-west Pacific (28° 43′ S, 154° 11′ E). As his specific name *semicostata* was preoccupied by Seguenza for a form of *L. semistriata* (*Phialina semicostata*, Seguenza, 1862, FMMM, p. 45, pl. i, fig. 19), I have renamed the species after A. J. Clowes, M.Sc., A.R.C.S., of the Discovery staff.

324. **Lagena compresso-marginata**, Sidebottom.

Lagena compresso-marginata, etc., Fornasini, 1889, MPPS, No. 16, fig. 16.
Lagena compresso-marginata, Sidebottom, 1912, etc., LSP, 1913, p. 187, pl. xvi, fig. 21.

Three stations: 385, 386; WS 403.

Two very fine examples and one weaker from St. WS 403, and single excellent specimens at Sts. 385 and 386, all in deep water in the Drake Strait and Scotia Sea. The best specimens resemble Sidebottom's figure but have no basal spine. The costae and carina are strongly developed.

Fornasini's figure is a crude little woodcut to which he gives no name, merely describing his specimen as "*Lagena* compresso-marginata, modificazione parzialmente striata (nella parte aborale) della *L. marginata* W. e B." His figure shows no basal spine but the carina is apparently well developed. His specimens were from a Pliocene marl near Bologna.

The specific name must be attributed to Sidebottom, as the words *compresso-marginata* were evidently used by Fornasini in a descriptive sense. They are not printed in italics like the generic name *Lagena*, or the other specific names in the paper.

325. **Lagena costata** (Williamson) (F 195) (SG 207).

Ten stations: 170, 175, 363, 383–5, 387; WS 403, 468, 482.

Rare everywhere, the best series at St. 170 where there was some range of variation in the relative number and coarseness of the costae. The type of Williamson without produced neck was found at this station, also at Sts. 384, 387 and WS 482, but often in company with a variety with short produced neck, linking the species with *L. sulcata*. This variety represents the species at the remaining stations.

326. **Lagena danica**, Madsen (F 234) (SG 208).

One station: 170.

Very rare but typical.

327. **Lagena deaconi**, sp.n. (Plate VI, figs. 48, 49).

Two stations: 385, 386.

Test hyaline, a compressed and elongate flask, thickest and widest near the base, narrowing and thinning out to the oral extremity, which is at the end of a produced neck with reverted lip. The edges of the flask are broad and rounded at the base and sides, thinning out into a wide finely tubulated carina on each side of the neck. From the extremity of the neck two costae diverge, following the neck and gradually disappearing into the outer edges of the flask. The basal portion of each face is produced downwards and outwards into strong cusps which overhang the base, and curving inwards are serrated on their inner edges. The test is thickest at the cusps, which would appear to be hollow cavities, not connected with the interior of the test.

Length about 0·45 mm.; maximum breadth about 0·23 mm.; thickness 0·15 mm.

Three good specimens at St. 385, and a broken test at St. 386. Both stations are in the Drake Strait, depths 3638 and 4773 m. respectively.

This is a very remarkable and distinctive form, so unlike other species that it is difficult to describe, but the illustrations will help. The nature of the basal cusps is doubtful, but in the broken specimen found at St. 386, one is revealed as a hollow cavity not connected with the interior of the test.

Sidebottom figures some specimens from the south-west Pacific under the name *L. clypeato-marginata*, Rymer Jones var. *crassa*, which are nearer *L. deaconi* than anything else I know. They possess cusps, but more inflated than in my species, and the whole test has a wide carina which extends between and beyond the cusps (S. 1912, etc., LSP, 1912, p. 425, pl. xxi, fig. 7). Neither his variety nor my species appears to have any affinity with *L. vulgaris* var. *clypeato-marginata*, Rymer Jones (J. 1872, RFL, p. 58, pl. xix, fig. 37).

The species is named after Mr G. E. R. Deacon, B.Sc., of the Discovery staff.

328. **Lagena desmophora**, Rymer Jones (Plate VI, figs. 44, 45).

Lagena vulgaris var. *desmophora*, Rymer Jones, 1872, RFL, p. 54, pl. xix, figs. 23, 24.
Lagena desmophora, Brady, 1884, FC, p. 468, pl. lviii, figs. 42–3.
Lagena desmophora, Cushman, 1910, etc., FNP, 1913, p. 27, pl. xii, fig. 5(?); xiii, fig. 3.

Six stations: 383, 384–6; WS 403, 468.

Rare everywhere, but excellent specimens at several stations, the best at Sts. 385 and 386. They are principally of the form figured by Brady but even more strongly developed. The loops on the ridges become stronger as they approach the base of the shell, and in a few instances form outstanding tubules projecting from the base.

Rymer Jones gives two figures of his species which are not at first view comparable. Fig. 23 (*ut supra*) is a simple flask with catenulate ornament only. At St. 384 was found a single specimen almost exactly comparable with Fig. 23. It is a long oval and hyaline flask with sulcate neck and spinous base. The ornament consists of weak costae with a few catenulate pits on them, extending over the basal half of the shell. Fig. 24 has prominent wings but the ornament appears to be similar to fig. 23. Neither of the original figures has much superficial resemblance to the strongly costate forms figured by Brady, but *L. torquata* Brady (No. 408) has characters intermediate between the two extremes. Zoologically, I think *L. torquata* (Plate vi, fig. 43) should be regarded as a synonym of *L. desmophora*, which species would then include all variations between the thin-walled type of Rymer Jones (Plate vi, fig. 44) and the thick-walled form of Brady (Plate vi, fig. 45).

I do not think the specimens figured by Cushman in his recently published Tropical Pacific monograph (C. 1932, etc., TPA, 1933, p. 29, pl. vii, figs. 11–14) are properly referable to this species. They appear to represent a variety of *L. striato-punctata*, Parker and Jones, and may be compared with Sidebottom's figures of similar varieties of that species (S. 1912, etc., LSP, 1912, pl. xvi, figs. 7, 8).

329. **Lagena distoma**, Parker and Jones (F 186) (SG 209).

Seven stations: 180, 187, 195, 196; WS 205, 485, 487.

Very rare, seldom more than a single specimen at each station, and all very small compared with the dimensions often attained in the North Atlantic.

330. **Lagena exsculpta, Brady.**

Lagena exsculpta, Brady, 1879, etc., RRC, 1881, p. 61; 1884, FC, p. 467, pl. lviii, fig. 1; pl. lxi, fig. 5.

Lagena exsculpta, Cushman, 1910, etc., FNP, 1913, p. 28, pl. xiii, fig. 5.

Two stations: 384, 386.

Two typical specimens of the globular type at St. 386, and several of the compressed form at St. 384. In some of the compressed specimens the costae between the "furrows" or grooves are very strongly developed beyond the base.

Brady (*ut supra*) gives as a synonym of his species *Lagenulina sulcata*, Terquem (T. 1875, etc., APD, part 2, 1876, p. 68, pl. vii, fig. 9). But Terquem describes his specimen as "*velut costata*", and the shading of the excellent figure indicates plainly that the markings are solid raised costae extending over the basal half of the shell, and not grooves excavated in the shell, as in *Lagena exsculpta*.

331. **Lagena fasciata (Egger) var faba, Balkwill and Millett (F 213) (SG 211).**

One station: WS 482.

A single rather weak specimen.

332. **Lagena felsinea, Fornasini (SG 212).**

Twelve stations: 363, 373, 383–6; WS 204, 383, 468, 485, 506, 507B.

Very rare, generally represented by one or two typical specimens, except at St. WS 468, where it is not uncommon. The species appears to be quite cosmopolitan, though in our material it is almost confined to deep water.

333. **Lagena fimbriata, Brady (F 232) (SG 213) (Plate VI, figs. 46, 47).**

Eight stations: 201, 366, 383–6; WS 403, 507B.

One or two small and weak specimens at Sts. 201, 366 and WS 507B. More frequent but never common at the remaining stations where it attains typical development, and at which many of the specimens have a dense fringe of very delicate spines filling the spaces between the basal carinae, and sometimes extending considerably beyond them. The best examples of this were found at Sts. 384 and WS 403.

334. **Lagena fimbriata var. occlusa, Sidebottom (F 233).**

One station: 385.

A few typical specimens.

335. **Lagena formosa, Schwager (SG 214).**

Five stations: 384–6; WS 403, 469.

Confined to the very deep-water stations in the Drake Strait and Scotia Sea, two of the stations being outside the Antarctic convergence line. It is rare everywhere except at St. 385, where it is not uncommon. Most of the specimens are very large and typical, except at St. WS 469, where the single example was small but with a very long neck. At Sts. 384 and 386 enormous but fragmentary specimens were obtained, the largest must have measured over 1·5 mm. in length when perfect. At St. WS 403 the species was represented by two large specimens with very feeble striations on the face, not sufficiently strong to entitle them to separation under Brady's varietal name *comata*.

336. **Lagena formosa var. costata**, Earland (SG 215).

Five stations: 384–6; WS 403, 469.

Very rare everywhere, but good and typical specimens. At St. 385, where it was less uncommon, there was some range in the number and strength of the costae, and the variety merged into small specimens of *L. formosa* found at that station.

337. **Lagena foveolata**, Reuss (F 204) (SG 216).

Six stations: 383, 385, 386; WS 403, 505, 507B.

Only single specimens, except at Sts. 385, WS 403, where a series showing considerable range in the strength of the striae was obtained; also an apiculate specimen at St. 385. At Sts. 383 and WS 507B specimens were found in which the outer coating of the test was partly or wholly denuded, leaving a delicate hyaline shell studded with rows of the very short spines, which normally support the outer coat of its double-walled test.

338. **Lagena foveolata var. paradoxa**, Sidebottom.

Lagena foveolata, var. *paradoxa*, Sidebottom, 1912, etc., LSP, 1912, p. 395, pl. xvi, figs. 22, 23; 1913, p. 177, pl. xv, fig. 32.
Lagena paradoxa, Cushman, 1932, etc., TPA, 1933, p. 29, pl. vii, figs. 9, 10.

Four stations: 383, 384, 385; WS 403.

Only single specimens, except at St. 385, where it is more abundant and some of the specimens are strongly sulcate. All the stations are in the Drake Strait or Scotia Sea and over 3700 m. Sidebottom's variety is distinguishable only by the coarseness of the external markings and seems hardly worth separating from the type.

Sidebottom's records were from the south-west Pacific, and Cushman (*ut supra*) has recently recorded and figured the form from the Tropical Pacific, his figures being excellent. He had previously recorded and figured specimens from the North Atlantic under the name *L. paradoxa* (C. 1918, etc., FAO, 1923, p. 45, pl. viii, fig. 11), but the figure is not recognizable, and it seems doubtful whether it represents the same organism. In any case the specific name *paradoxa* has already been used by Seguenza for a different organism (*Fissurina paradoxa*, Seguenza, 1862, FMMM, p. 61, pl. ii, fig. 7). In strictness I suppose the varietal name should be changed.

339. **Lagena glans**, sp.n. (Plate VI, figs. 50, 51).

One station: 385.

Test shaped like an acorn in its cup; the "cup" or aboral end forms about one-sixth of the test but does not project beyond the rest of the shell. The cup is covered with a close network of reticulated sculpture and has a slightly projecting basal spine or tube. Between the reticulate surface of the cup and the smooth "acorn" portion of the test a line of minute arched grooves encircles the test. The acorn portion of the test is smooth; wall thick, becoming solid towards the central aperture at the tip of the acorn.

Total length nearly 0·6 mm.; maximum breadth 0·32 mm.

Only a single specimen in fine preservation from 3638 m. in the Drake Strait. It is evidently nearly related to *L. sidebottomi* (No. 393), but is sufficiently distinctive to require specific determination.

340. **Lagena globosa (Montagu) (F 169) (SG 217).**

Nineteen stations: 163, 170, 175, 177, 180, 196, 363, 383–6; WS 204, 403, 468, 469, 481, 482, 507B, 517.

Frequent at Sts. 384, 385, where, in addition to fragments of typical specimens of enormous size, almost every variety occurred, including ento-ectosolenian specimens, specimens with broad everted rims round the aperture and compressed specimens of the fissurine type (= *Fissurina globosa*, Bornemann). This fissurine form represents the species at several stations including Sts. 177, 363 and WS 507B, but generally speaking it has the same distribution as the type. At most of the stations the species grows to large dimensions, particularly noteworthy at Sts. 163, 170, 384, 385, 386, and WS 482. These very large specimens usually have a simple basal aperture, in addition to the normal radiate aperture of the type.

341. **Lagena globosa var. emaciata, Reuss.**

Lagena emaciata, Reuss, 1862 (1863), FFL, p. 319, pl. i, fig. 9.
Lagena globosa var. *emaciata*, Sidebottom, 1912, etc., LSP, 1912, p. 381, pl. xiv, figs. 13–15; 1913, p. 165.

Three stations: 385; WS 506, 507A.

The only records which have been preserved are single specimens from these stations. The variety probably occurs at many others but has been overlooked or associated with *L. apiculata*.

342. **Lagena globosa var. setosa, var.n. (Plate VI, fig. 52).**

Lagena longispina, Brady, 1879, etc., RRC, 1881, p. 61.
Lagena longispina, Brady, 1884, FC, p. 454, pl. lvi, figs. 33–5 (not 36 or pl. lix, figs. 13–14).
Lagena longispina, Sidebottom, 1912, etc., LSP, 1913, p. 165, pl. xv, figs. 5, 6.

Four stations: 386; WS 400, 403, 469.

A single specimen at each of these deep-water stations in the Drake Strait, depths 3959–4773 m. They are merely a variety of *L. globosa* in which the base is covered with short solid spines or hairs.

Brady says that his species *L. longispina* is "only a variety of *L. globosa*, the shell of which is armed at the base with a number of spines, either irregularly placed or, in the compressed forms, springing from near the median line. Sometimes the spines attain large dimensions, and specimens have been found in which they measure nearly twice the length of the body of the test".

His figures appear to represent two very distinct forms. The Figs. 33–5 on pl. lvi are, as he states, only a variety of *L. globosa* and identical with Sidebottom's specimens and my own. The figures on pl. lix, however, and probably pl. lvi, fig. 36, represent a form bearing long extensions, which I cannot regard as homologous with the short spines borne by the other specimens. I suggest that Brady's name be confined to the long-spined form.

343. **Lagena globosa var. tenuissimestriata, Schubert (Plate VII, figs. 50, 51).**

Lagena globosa var. *tenuissimestriata*, Schubert, 1911, FFB, p. 67.

Two stations: 175, 180.

A single specimen at each station, depths 200–160 m.

The variety differs from the type only in a surface decoration of extremely fine striae, and would be hardly worth separating but for the fact, to which Schubert draws attention, that *L. globosa* is notorious for the glassy smoothness of its surface. Schubert's specimens were from a fossil *Globigerina* ooze in the Bismarck Archipelago, New Guinea, and he attributes the markings on his variety to their deep-water habitat. But the Discovery specimens are from shallow water, and though there are abundant specimens of *L. globosa* from the deep-sea stations, they are all typically glassy and smooth.

344. **Lagena gracilis**, Williamson (F 185) (SG 218).

Fifteen stations: 170, 175, 194, 196, 384–6; WS 204, 387, 395, 403, 468, 482, 505, 506.

Always very rare except at the deep-water stations 385 and 386, where it is frequent. Most of the specimens are of a short coarse type, with few costae.

345. **Lagena gracillima** (Seguenza) (F 177) (SG 219).

Nine stations: 185, 206, 383–6; WS 394, 403, 476.

Only single specimens, except at Sts. 384, 385 and 386, where many excellent examples were obtained. These stations are all in the deep water of the Drake Strait. The specimens found at Sts. 185 and WS 394 are of the curved form figured by Brady, and referred to in the Falklands (F 177) and South Georgia (SG 219) reports.

346. **Lagena guntheri**, sp.n. (Plate VI, figs. 53, 54).

Two stations: 384; WS 469.

Test in the form of a pear-shaped flask, thick-walled, more or less acutely pointed at the oral extremity. From a basal ring stout costae, 6–8 in number, run up the sides of the test for three-quarters of its length, then arch over and join. The intercostal spaces are concave. Above the arches, where the costae coalesce, a single row of hexagonal pits, equal in number to the costae, forms a ring round the neck of the flask, and above this ring the test ends in a blunt oral extension with central aperture.

Length 0·22 mm.; breadth and thickness 0·16 mm.

Several good specimens at St. 384, one less typical at St. WS 469; both stations are in deep water in the Drake Strait. The species is associated with the name of E. R. Gunther, M.A., of the Discovery staff.

L. guntheri is a distinctive modification of *L. acuticosta*, Reuss, its nearest ally. The single row of hexagonal pits suggests affinities with *L. williamsoni* and *L. vilardeboana*. All these species are no doubt zoologically nearly akin.

347. **Lagena hartiana**, Earland (SG 220).

Three stations: 385, 386; WS 403.

Two good specimens from each of Sts. 385 and 386, and another from St. WS 403. They all come from deep water in the Drake Strait and Scotia Sea. St. 386 is outside the Antarctic convergence line. The number of costae in this species appears to be subject to variation, one of the specimens from St. 386 having only three costae; all the others have the normal five.

348. **Lagena heronalleni**, sp.n. (Plate VI, figs. 55–57).

Lagena striato-punctata (*pars*), Heron-Allen and Earland, 1922, TN, p. 149, pl. vi, figs. 5, 19.

Four stations: 170, 175, 195; WS 482.

Test large, flask-shaped, with a short stout neck tapering into the body which is ornamented with a variable number (up to 20 or more), of broad and flattened costae which are divided by cross-bars into rectangular pits. The whole surface of the rib is covered in with a thin membranous shell, converting the pits into cells. The costae run up into the neck, and the intervals between the costae are filled with a spongy white shell substance which contrasts with the dark hyaline ribs. In worn and abraded specimens the outer covering of the costae disappears, and the ribs stand up from the body of the test, covered with large pits.

Length about 0·60 mm.; maximum breadth and thickness about 0·35 mm.

Very rare at all stations, which with one exception, St. 170 off Clarence Island, 342 m., are in the Bransfield Strait area, 100–391 m.

This large and striking species was first discovered in 45–50 fathoms off Cape Adare in the Ross Sea, and was included in the Terra Nova report among the varieties of *L. striato-punctata*. But as a double-walled species it belongs to the same group as *L. scottii* and *L. texta*, and I have named it after my collaborator in the Terra Nova and other reports.

349. **Lagena hexagona** (Williamson) (F 202) (SG 222).

Eight stations: 170, 175, 177, 363, 383, 385, 386; WS 469.

Very rare everywhere, but remarkably fine and typical specimens especially at the deep-water stations in the Drake Strait. Here the walls of the hexagonal pits are very high, reaching their maximum in a single specimen at St. 385, in which the high walls tend to have spinous fringes, particularly round the basal hexagons. Sidebottom refers to a similar variation in the south-west Pacific (S. 1912, etc., LSP, 1913, p. 172).

350. **Lagena hispida**, Reuss (F 181).

Four stations: 384, 385; WS 497, 509.

Only a single specimen at each station. That from St. 384 is a large specimen of the type figured in the Falklands report (pl. x, fig. 7) in perfect condition, the external coating being unbroken, and only the neck exhibiting the spines. The specimen from St. WS 509 is pyriform with short spines.

351. **Lagena hispidula**, Cushman (F 180) (SG 223) (Plate VI, figs. 58–60).

Seventeen stations: 170, 175, 177, 190, 363, 383–6; WS 204, 403, 468, 469, 507A, 507B, 515, 517.

Frequent and very varied at St. WS 403, where the specimens range from globular to narrowly cylindrical, all being provided with very long necks. Rare or very rare at the other stations. At St. 170 the flask is globular with produced neck, while at Sts. WS 507A, 507B and 515 the flask is narrow and cylindrical, which form seems more usual in the higher latitudes. Cushman's figures do not give any idea of the range of form, which is quite as variable as in *L. laevis*. The depth ranges between 329 and 4773 m., but the finest specimens were found at the deeper stations.

Cushman's species is one of the double-walled *Lagenae*, and very similar in structure to *L. chasteri*, Millett (M. 1898, etc., FM, 1901, p. 11, pl. i, fig. 11), though much thinner. The external layer of an undamaged specimen is very finely vesicular, but smooth and shining. It appears to consist of innumerable little prisms or spines set closely together on the surface of the inner shell. When the outer shining layer is damaged either in places or entirely, the inner shell is seen to be dull like ground glass, sometimes faintly hispid where the prisms remain undamaged. The neck is thick and solid looking, and when the surface layer is removed the fine undergrowth is very readily seen. The figures show the structure better than any description. Specimens of every shape, from globular to elongate oval, were found in all conditions between the undamaged shells, and those in which the outer covering had entirely disappeared.

352. **Lagena inornata** (d'Orbigny) (F 175).

Two stations: WS 393, 482.

A single good specimen at each station.

353. **Lagena johni**, sp.n. (Plate VI, figs. 61–63).

Five stations: 383–6; WS 403.

Test hyaline, cordate, somewhat compressed, lateral edges rounded; walls rather thick, becoming solid at the slightly produced oral extremity which has an entosolenian tube. The upper half of the test is smooth, the lower half deeply sculptured into a series of arches, from the sides of which sharp carinae extend downwards beyond the base, more or less concealing two large diverging auricles situated on the base.

Length varies up to 0·40 mm.; breadth up to 0·30 mm.; thickness 0·20 mm.

Rare everywhere, the best and most frequent specimens at St. 384. At this station and at St. 385 the carinae reach their maximum development. At Sts. 383, 386 and WS 403 the carinae are not so prominent. They are very fragile and it is not easy to distinguish specimens in which they have been broken away from those in which development has been arrested. The species is associated with the name of D. D. John, M.Sc., of the Discovery staff.

L. johni is allied to *L. auriculata*, Brady, as evidenced by the large auricles on the base. In its sculptured markings it resembles to some extent *L. exsculpta*, Brady. Its nearest ally is probably *L. auriculata* var. *arcuata*, Sidebottom (see No. 311), and it is not easy to separate worn examples of *L. johni* from that variety, except by the absence of the marginal carina which distinguishes Sidebottom's form.

354. **Lagena laevigata** (d'Orbigny) (F 169 A).

Oolina laevigata, Galloway and Wissler, 1927, PPLQ, p. 50, pl. viii, fig. 10.

Five stations: 170, 175, 384, 385; WS 403.

Single specimens only at the three deep-water stations, 384, 385 and WS 403, and these very small in size compared with those from comparatively shallow water at Sts. 170 and 175, where it is more frequent, and the specimens are large and typical. The base is variable, sometimes rounded, at others produced and flattened, often with a central depression which is apparently superficial, and not as might be supposed a secondary aperture. This basal depression and the solid conical neck may indicate affinities with *L. stelligera*. It was stated in the Falklands report that d'Orbigny's species had been overlooked by subsequent authors. An exception has since come under my notice. Galloway and Wissler (*ut supra*) record it as rare in the Pleistocene of Lomita Quarry, and very rare in the Pliocene of Timms Point, both in California. Their figure is unmistakable.

355. **Lagena laevis** (Montagu) (F 179) (SG 224).

Eight stations: 175, 384–6; WS 383, 403, 468, 482.

The species has a wide range in depth between 100 m. at St. WS 482 and 4773 m. at St. 386. It is never very common, and in the case of dead shells not easily distinguishable from *L. hispidula*. Every variety of shape is found, sometimes (as at St. 385) at one station. The typical glassy oval form with long neck was found here and at St. 384. The length of the neck is variable, often exceeding that of the flask, but at St. 175 the neck is short and thick, and at St. WS 482 it is practically absent. A very striking variety occurs at Sts. 384, 385, 386 and WS 403, with massive almost globular body surmounted by a broad short neck with reverted lip, the neck being more or less corrugated. It agrees fairly well with Sidebottom's figure (S. 1912, etc., LSP, 1913, pl. xv, fig. 9), but is usually thick-shelled and dull white in colour. A similar but hyaline example at St. 386 confirms the assignation of the other specimens to *L. laevis*.

356. **Lagena lagenoides** (Williamson) (F 226) (SG 225).

Three stations: 387; WS 468, 482.

Extremely rare. The single specimens at Sts. 387 and WS 482 are very near Williamson's figure, that from St. WS 482 being trigonal in the proximity of the neck.

357. **Lagena lagenoides var. debilis**, var.n. (Plate VII, fig. 1).

Lagena lagenoides, Sidebottom, 1912, etc., LSP, 1912, p. 413, pl. xviii, fig. 29; 1913, p. 190.
Lagena lagenoides (*pars*), Cushman, 1932, etc., TPA, 1933, p. 24, pl. vi, figs. 3 *a*, *b* (only).

One station: WS 482.

Among the many varieties of *L. lagenoides* figured by Sidebottom from the south-west Pacific is one in which the marginal carina is reduced to a mere band, visible only in edge view. In his figure the tubules of the carina show only as a dotted line in the margin of the side view. Describing his figure he says, "the band at the edge is practically flush with the body of the test".

There is little doubt that Sidebottom's specimens are a degenerate variety of *L. lagenoides*, but they are sufficiently distinctive for a varietal name.

A single specimen from 100 m. at St. WS 482 in the Bransfield Strait is unquestionably identical with Sidebottom's variety, but even more pauperate. It is a trigonal form, and the marginal carina is reduced to a mere ghostlike band in which the tubuli are represented by white spots. It is thin-walled and glassy with a long unattached entosolenian tube, and what is apparently a secondary aperture at the obtusely pointed base.

Length 0·42 mm.; breadth across each of the three faces 0·20 mm.

358. **Lagena lagenoides var. radiata (Seguenza) (F 227).**

Five stations: 384–6; WS 204, 403.

Very rare, but some very fine specimens were found at these deep-water stations. The wing is flat, not sigmoid as in Silvestri's figure. The surface of the flask is generally rough or stippled, sometimes faintly striate; but the markings are not strong enough to compare them with *L. sublagenoides* var. *striatula*, Cushman (C. 1910, etc., FNP, 1913, p. 40, pl. xvi, fig. 5), although the specimens at St. 386 approach that variety.

359. **Lagena lagenoides var. tenuistriata, Brady (F 228) (SG 226).**

Three stations: 383, 385; WS 403.

A single excellent specimen at St. 383; more frequent at the other stations.

360. **Lagena laureata, Heron-Allen and Earland (F 244).**

One station: WS 505.

A single very weak specimen. The species is abundant in the Falklands area but did not occur in South Georgia.

361. **Lagena lineata (Williamson) (F 183) (SG 227).**

Four stations: 170, 177, 363; WS 468.

Extremely rare, usually only a single specimen at each station. The depths range between 329 and 4344 m. At the greatest depth, St. WS 468, the single specimen is quite typical though rather coarsely marked. The others are of a more globular form, such as were recorded from South Georgia, and the markings range between fine and coarse striae.

362. **Lagena lucida (Williamson) (F 214) (SG 228).**

One station: 170.

Curiously enough this ubiquitous species occurs only at St. 170, where it is not uncommon and the specimens are large and typical.

363. **Lagena malcomsonii, J. Wright (F 217).**

One station: 187.

A single specimen only from the Palmer Archipelago, in 200 m.

364. **Lagena marginata (Walker and Boys) (F 221) (SG 232).**

Twenty-two stations: 170, 175, 177, 181, 187, 190, 194, 195, 200, 363, 384–7; WS 204, 403, 468, 481, 482, 483, 485, 505.

Frequent and variable at Sts. 385, WS 482 and 483, more or less rare at the other stations. The majority of specimens have a carina of narrow or medium width, but specimens with broad carinae were found at some of the deeper stations, notably Sts 384, 385, 386 and WS 403. Fragments of what must have been enormous individuals were found at Sts. 384 and 385.

365. **Lagena marginata var. cushmani, Wiesner (Plate VII, fig. 2).**

Lagena marginata var. Cushman, 1910, etc., FNP, 1913, p. 38, pl. xxi, fig. 2.
Lagena cushmani, Wiesner, 1931, FDSE, p. 121, pl. xix, fig. 225.

Two stations: 170, 385.

Several specimens at St. 170, and a single individual at St. 385. The variety is characterized by the keel, which is broadest at the base and gradually diminishes towards the produced and solid oral end. It is very similar to *L. marginata* var. *fissa*, which also occurs at St. 170, but the keel is continuous at the base, and not split as in var. *fissa*.

The specimen from St. 385 is not typical, the keel ending abruptly at less than half the length of the shell.

366. **Lagena marginata var. fissa, Heron-Allen and Earland.**

Lagena marginata var. *fissa*, Heron-Allen and Earland, 1922, TN, p. 157, pl. v, figs. 24–5.
Lagena (*Entosolenia*) *marginata* var. *fissa*, Wiesner, 1931, FDSE, p. 121, pl. xix, fig. 226.

Two stations: 170; WS 482.

This curious variety, "in which the keel, rapidly increasing in breadth over the basal quadrant of the shell, is deflected just before reaching the aboral extremity and as rapidly decreases in breadth and vanishes, with the result that the extreme aboral end of the shell shows two keels somewhat widely separated", occurs only at Sts. 170 and WS 482, where it is well developed and not uncommon.

It was originally described from the Ross Sea, and has recently been recorded and figured by Wiesner from off Kaiser Wilhelm's Land. Its occurrence in the opposite sector of the Antarctic indicates a circumpolar distribution.

367. **Lagena marginata var. homunculus, Sidebottom.**

Lagena marginata, var.n. *homunculus*, Sidebottom, 1912, etc., LSP, 1912, p. 409, pl. xviii, fig. 15.

One station: 385.

A single specimen from 3638 m. in the Drake Strait which is probably referable to Sidebottom's curious variety, although it is weakly developed as regards the basal spines—the "feet" of the "little man"—which are inconspicuous. The aboral half of the test is rough.

368. **Lagena marginata var. quadricarinata, Sidebottom (SG 233).**

One station: WS 505.

Two remarkably fine specimens resembling those from South Georgia in the absence of basal spines, but with typical development of the carinae.

369. **Lagena marginata var. semimarginata, Reuss (F 222).**

Five stations: 170, 175, 385, 386; WS 482.

Only a few specimens at each station, very good and typical at Sts. 170 and WS 482.

370. **Lagena marginata var. spinifera, var.n. (Plate VII, figs. 3, 4).**

Lagena acuta, Brady (*non* Reuss), 1884, FC, p. 474, pl. lix, fig. 6.
Lagena sacculus, Cushman (*non* Fornasini), 1910, etc., FNP, 1913, p. 8, pl. iii, figs. 1–3.
Lagena marginata, Sidebottom, 1912, etc., LSP, 1912, p. 407, pl. xviii, figs. 4, 5; 1913, p. 187.

Five stations: 384–6; WS 468, 469.

Test compressed, lenticular, furnished with a narrow carina extending into the produced neck, and with a basal spine.

Single specimens except at St. 385 where it is more frequent. All the stations are in very deep water.

Brady does not appear to have met with typical *L. acuta*, Reuss, in the Challenger material. He figures a specimen (*ut supra*) which he says is not typical and "might with equal propriety be treated as a mucronate example of *L. marginata*". His specimen was from deep water in the South Atlantic, Challenger St. 332, 2200 fathoms. I think there can be no doubt that his specimen is referable to *L. marginata* var. *spinifera*.

Cushman figures under the name *L. sacculus*, Fornasini, a series of specimens from deep water in the Pacific which are unquestionably the same as that figured by Brady, though they exhibit great range in the width of the keel. They cannot be identified with Fornasini's species (F. 1901, NNI, p. 49, fig. 3), which is described as having a rounded edge, with which description Fornasini's figure agrees absolutely.

371. **Lagena marginata var. striolata**, Sidebottom (SG 234).

One station: 384.

A single example resembling the South Georgia specimens, and Sidebottom's fig. 10 (S. 1912, etc., LSP, 1912, p. 408, pl. xviii, fig. 10).

372. **Lagena melo** (d'Orbigny) (F 200) (SG 235).

Five stations: 175, 200, 384, 386; WS 482.

Only a single specimen at each station, except St. WS 482, where the best specimens were found. There is a great range in depth between 100 m. at St. WS 482 and 4773 m. at St. 386.

373. **Lagena multicosta** (Karrer).

Fissurina multicosta, Karrer, 1877, KFJW, p. 379, pl. xvi *b*, fig. 20.
Lagena multicosta, Brady, 1884, FC, p. 466, pl. lxi, fig. 4.
Lagena multicosta, Millett, 1898, etc., FM, 1901, p. 495, pl. viii, fig. 17.
Lagena multicosta, Heron-Allen and Earland, 1922, TN, p. 148.

Two stations: 386; WS 403.

A single specimen from each station is in close resemblance to Karrer's figure. A second specimen from St. 386 is distinguished by a stout but short neck; in other respects it appears to be referable to Karrer's species. Brady's specimen has basal spines which are also indicated by Millett, but they are not shown in Karrer's original figure.

374. **Lagena orbignyana** (Seguenza) (F 240) (SG 236).

Eleven stations: 170, 177, 383–6; WS 204, 403, 468, 469, 482.

Frequent at Sts. 385 and WS 403, rare or very rare elsewhere. Several very distinctive forms were observed. The true type of Seguenza, practically without neck, occurs at St. 170. The same type but with all three keels very much extended, the middle carina particularly, was found at Sts. 177, 384, 385, WS 403 and 482. It is identical with *L. orbignyana* var. *alata*, Cushman (C. 1910, etc., FNP, 1913, p. 45, pl. xxiii, fig. 1), except that it lacks the pitted markings round the border of the face of the test. A third form has an oval body with short produced neck, carinae narrow but thick, extending to form costae on the neck. The intracarinal spaces are rough with a tendency to become hispid, which is most marked at St. WS 468. It occurs also at Sts. 385, 386, WS 204 403 and 469. A fourth variety in which the carinae are inconspicuous, but the central carina is produced as a wing up the sides of the neck, occurs at Sts. 383 and 385.

375. **Lagena orbignyana var. unicostata**, Sidebottom.

Lagena orbignyana, var.n. *unicostata*, Sidebottom, 1912, etc., LSP, 1912, p. 417, pl. xix, fig. 22; 1913, p. 195.

Three stations: 385, 386; WS 403.

Two specimens at St. 385 identical with Sidebottom's fig. 22, but the single specimen at WS 403 is more strongly developed, the three carinae being very broad and the central costa equally strongly developed. A single poor specimen at St. 386.

376. **Lagena ovum** (Ehrenberg) (F 172).

One station: WS 507A.

A single typical specimen only.

377. **Lagena palliolata**,[1] sp.n. (Plate VII, figs. 5, 6).

One station: 384.

A single specimen from 3713 m. in the Drake Strait.

The test is an oval flask with a long produced neck. A carina of moderate width surrounds the flask and is continued up the sides of the neck, widening towards the aperture and forming a hood enclosing the upper portion of the neck. The basal half of the flask is ornamented with two concentric ridges.

Length 0·28 mm.; greatest breadth near base 0·14 mm.; greatest thickness of flask 0·11 mm., and of hood 0·07 mm.

This is a very distinctive form in the peculiar hood formed by an extension of the encircling carina. Such developments are not common and appear to be confined to deep-water *Lagenae*. Galloway and Morrey (G. and M. 1929, LTE, p. 22, pl. ii, fig. 17) figure a hooded form under the name *Fissurina orbignyana caribaea*, which is not a bit like Cushman's original description and figure of that variety (*Lagena orbignyana* (Seguenza) var. *caribaea*, C. 1918, etc., FAO, 1923, p. 41, pl. vii, figs. 6–9). Cushman figures another hooded form (C. 1932, etc., TPA, 1933, p. 35, pl. ix, fig. 1) which he calls a trigonal form of *Lagena pulchella*, Brady, but which does not suggest that very weak species. In its other features *L. palliolata* is suggestive of two different species. The carina investing the neck and flask resembles *L. marginata* var. *semimarginata* (No. 369). The concentric ridges on the flask recall the figures of *L. orbignyana* var. *concentrica* (S. 1912, etc., LSP, 1912, p. 417, pl. xix, fig. 23, and C. 1910, etc., FNP, 1913, p. 44, pl. xix, fig. 2) and of *L. orbignyana* var. *semiconcentrica* (C. 1925, etc., LFR, 1933, p. 10, pl. i, fig. 22).

378. **Lagena protea**, Chaster (F 206).

Two stations: 386; WS 468.

A single excellent specimen at each station. They are both in very deep water in the Drake Strait and outside the Antarctic convergence line. The species has already been recorded from 200 fathoms in McMurdo Sound, Ross Sea (H.-A. and E., 1922, TN, p. 153), and under the name *L. hispidipholus*, Pearcey, from 56 fathoms on the Burdwood Bank (P. 1914, SNA, p. 1020, pl. ii, figs. 11–13).

379. **Lagena pseudauriculata**, sp.n. (Plate VII, figs. 7, 8).

Two stations: 175; WS 482.

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[1] *palliolatus*=cowled or hooded.

Test rather compressed or lenticular, thinnest at the oral end which is somewhat produced and solid. Aperture fissurine, with entosolenian tube attached to one face and extending to the base of the shell. Edge subacute from the oral extremity to the middle of the test, at which point the edge divides for a time to form an "auricle", the containing walls of which do not project to any measurable extent above the flat floor. The base of the test between the "auricles" is rounded and sometimes produced to a blunt central point. Surface externally hyaline and polished, but in some lights having a frosted appearance caused apparently by the internal surface being matt. The surface of the flat "auricles" is opaque and granular, so that in side view they appear to be almost white. Size variable: average length 0·3 mm.; breadth 0·25 mm.; thickness 0·15 mm.

This is rather a distinctive form without any very decided affinities. Although the "auricles" suggest relationship with *L. auriculata*, they are in no sense pockets as in that species, but so superficial that they would be hardly noticeable, if their opacity did not contrast with the otherwise glassy surface of the test.

In some respects the test has a superficial resemblance to *L. revertens* (No. 385), but is devoid of the projecting neck and well-marked carinae of that species. It is rare at St. WS 482; a single fine specimen at St. 175; both stations are in the Bransfield Strait.

380. **Lagena quadralata**, Brady (F 230) (SG 237).

One station: WS 482.

A single specimen with six tubulated wings very weakly developed. The intermediate striae are by contrast quite strongly marked.

381. **Lagena quadrilatera**, sp.n. (Plate VII, figs. 10, 11).

Lagena quadrangularis, Heron-Allen and Earland (*non* Brady), 1922, TN, p. 160, no. 353.

Three stations: 384–6.

Test fusiform, four-sided, with acute and more or less carinate edges extending into a tapering neck bearing the simple oral aperture, and similarly extended into the bluntly pointed aboral extremity, which is sometimes furnished with a short terminal spine. The four faces of the test are slightly concave in cross-section at any point. Wall thick and smooth, glassy or dull white.

Length up to 0·50 mm.; breadth and thickness about 0·12 mm. Rare or very rare at all stations.

This form agrees with a few specimens obtained from very deep water in the Ross Sea by the Terra Nova, which were referred to *L. quadrangularis*, Brady (B. 1884, FC, p. 483, pl. cxiv, fig. 11).

L. quadrilatera differs from Brady's species, which was from shallow water in Torres Straits, in the shape of its cross-section, which is a square with concave sides; *L. quadrangularis* in similar section is a parallelogram with convex sides. It is probable that, in spite of their external similarity, the two species are not zoologically related, *L. quadrangularis* being apparently derived from *L. quadrata* or *L. bicarinata*, while *L. quadrilatera* is more likely to be connected with *L. gracilis*.

382. **Lagena quadrilatera var. striatula**, var.n. (Plate VII, fig. 9).

One station: 385.

A single specimen only. The variety differs from the type only in the finely striate surface of the test. The striae extend over the keels as well as the faces of the test.

383. **Lagena quadricostulata**, Reuss (F 216).

Two stations: WS 468, 469.

Very rare at both stations. The specimens are not typical, the costae being represented only by flush bands of more opaque shell material than the body of the test.

384. **Lagena reniformis**, Sidebottom (F 208) (Plate VII, figs. 12, 13).

Three stations: 175, 195; WS 482.

Very rare; only single specimens except at St. 175. All the stations are in the Bransfield Strait area.

385. **Lagena revertens**, Heron-Allen and Earland (F 238) (SG 240).

One station: WS 399.

Only a single typical specimen.

386. **Lagena schlichti** (A. Silvestri) (F 225) (SG 241).

Nine stations: 170, 177, 200, 383–6; WS 403, 507B.

Frequent, typical and large specimens at Sts. 384 and 385, rare or very rare at the remaining stations.

387. **Lagena scottii**, Heron-Allen and Earland (Plate VII, figs. 14, 15).

Lagena scottii, Heron-Allen and Earland, 1922, TN, p. 150, pl. vi, figs. 3, 4.
Lagena scottii, Heron-Allen and Earland, 1924, FQM, p. 150, pl. ix, figs. 39–41.

One station: 175.

A few large and typical specimens. They are not in such good condition as the types from Terra Nova St. 340 in the Ross Sea, 160 fathoms, the delicate outer membrane covering the reticulate surface being generally denuded.

388. **Lagena seguenziana**, Fornasini (Plate VII, figs. 16–18).

? *Fissurina marginata*, Seguenza (*non* Walker and Boys), 1862, FMMM, p. 66, pl. ii, figs. 27, 28.
? *Lagena orbignyana*, Brady, 1884, FC, pl. lix, fig. 1.
Lagena seguenziana, Fornasini, 1886, LF, p. 352, pl. viii, figs. 1–6.

Four stations: 385; WS 205, 403, 468.

Single specimens at Sts. WS 205 and 468, more frequent at the other stations but always very rare. All the stations are in deep water.

Fornasini's species is very distinctive, and we have no hesitation in assigning our specimens to it. The shell is round or slightly ovate, central area very inflated, then sinking into a channel inside the rim which is very broad and practically flat. There is a gradual increase in thickness from the oral to the aboral end. The aperture is at the extremity of a short neck tapering into the broad rim. Seen in edge view the highly convex faces of the test project beyond the flat rim.

Length up to 0·30 mm.; breadth 0·22 mm.; maximum thickness 0·13 mm., the rim being 0·1 of this measurement.

Fornasini regards his species as intermediate between *L. laevigata* (= *L. biancae*) and *L. orbignyana*. He points out that it is distinguishable from *L. bicarinata* by its flat edge, *L. bicarinata* having a deep groove between two carinae.

389. **Lagena semilineata**, J. Wright (Plate VII, figs. 19, 20).

Lagena semilineata, J. Wright, 1885 (1886), BLP, p. 320, pl. xxvi, fig. 7.
Lagena semilineata, Heron-Allen and Earland, 1916, FWS, p. 246, pl. xli, figs. 21, 22.

Three stations: 170, 383, 385.

Single specimens at Sts. 170 and 383, several at St. 385. They are all much more globular in form and more deeply grooved than Wright's type figure. The best specimen at St. 170, the others show a tendency to develop short spines over the base.

390. **Lagena semilineata var. spinigera**, var.n. (Plate VII, fig. 21).

Lagena semilineata, Sidebottom, 1912, etc., LSP, 1913, p. 173, pl. xv, fig. 27.

One station: 385.

Two specimens from this station are characterized by the abnormal development of a basal spine, which in one instance almost equals the length of the remainder of the test, including the long neck. The basal spines are solid. In other respects the specimens conform to Wright's type figure, except that the sculptured grooves on the basal half of the shell are fewer in number and more deeply cut. Sidebottom figures a somewhat similar specimen which he describes as "a bold form of *L. semilineata*". It is probable that the specimen figured by Brady (B. 1884, FC, pl. lviii, fig. 17) as "? Apiculate form of *Lagena sulcata*, Walker and Jacob" belongs to the same variety as ours, although the basal spines (two) are comparatively short. The markings in the plate are more suggestive of the grooves of *L. semilineata* than the costae of *L. sulcata*.

All the specimens referred to are from deep water.

391. **Lagena seminuda**, Brady (Plate VII, fig. 22).

Lagena seminuda, Brady, 1884, FC, p. 472, pl. lviii, fig. 34.
Lagena seminuda, Heron-Allen and Earland, 1922, TN, p. 153.

Three stations: 383, 386; WS 403.

A single specimen from each of these deep-water stations.

392. **Lagena semistriata**, Williamson.

Lagena striata var. *β semistriata*, Williamson, 1848, BSGL, p. 14, pl. i, figs. 9, 10.
Lagena vulgaris var. *semistriata*, Williamson, 1858, RFGB, p. 6, pl. i, fig. 9.
Lagena semistriata, Brady, 1884, FC, p. 465, pl. lvii, figs. 14, 16, 17.

Three stations: 384, 385; WS 468.

Rare or very rare everywhere. The general form is large, short-necked and nearly globular, with very strong costae over the basal half of the test. At St. WS 468, in addition to this form, there was a small and weakly marked specimen with a very long neck.

393. **Lagena sidebottomi**, nom.n. (Plate VII, fig. 23).

Lagena, "Intermediate form, resembling *L. crenata* and *L. semistriata*", Brady, 1884, FC, pl. lvii, fig. 20.

Lagena intermedia, Sidebottom (*non* Rzehak), 1912, etc., LSP, 1912, p. 399, pl. xvii, figs. 1–3; 1913, p. 180.
Lagena intermedia, Cushman, 1910, etc., FNP, 1913, p. 29, pl. xiii, fig. 4.

Three stations: 384, 385; WS 403.

Very rare, but excellent specimens of this normally Pacific species were found in the deep water of the Drake Strait and Scotia Sea.

Sidebottom's specific name had been anticipated by Rzehak, who described and figured a striate *Lagena* under the name *L. striata* var. *intermedia* (R. 1885, NMO, pp. 81 and 90, pl. i, fig. 6). I have therefore associated the species with the name of my late friend Henry Sidebottom, who did so much valuable work on the *Lagenae* of the Pacific.

Brady's earliest figure of the species was drawn from a Pacific specimen, Challenger St. 276, North of Tahiti, 2350 fathoms.

394. **Lagena squamosa** (Montagu) (F 197) (SG 243).

Four stations: 175, 200, 386; WS 482.

Only a single specimen at each station, none quite typical, the best at St. WS 482.

395. **Lagena squamoso-alata**, Brady (Plate VII, figs. 24, 25).

Lagena squamoso-alata, Brady, 1879, etc., RRC, 1881, p. 61; 1884, FC, p. 481, pl. lx, fig. 23.

One station: 363.

A very fine specimen was found at St. 363, off Zavodovski Island, in the South Sandwich group, depth 329 m. It agrees generally with Brady's figure, but has a basal cleft in the wing, and lacks the ring of areolae surrounding the central area. The type was from off West Ireland, 173–1445 fathoms, and I know of no other record, so that its occurrence in the Antarctic is noteworthy.

Length 0·5 mm.; greatest breadth 0·26 mm.; thickness 0·16 mm.

In *L. squamoso-alata* the areolae are covered in with a very delicate outer shell, quite transparent; similar double wall structure is found in *L. heronalleni* (No. 348), *L. squamoso-marginata*, Parker and Jones, *L. scottii*, Heron-Allen and Earland (No. 387), and *L. texta*, Wiesner (No. 407). No mention of this feature occurs in Brady's description of his species, but it can be seen in the type specimen in the British Museum (Natural History) which is in perfect condition, and the structure is clearly indicated in the type illustration by Hollick.

396. **Lagena squamoso-sulcata**, Heron-Allen and Earland (F 196A) (SG 244) (Plate VII, figs. 26–28).

Six stations: 170, 175, 363, 385; WS 468, 482.

Rare or very rare everywhere but a fine series of specimens, especially at Sts. 170 and WS 468. At the latter station a very remarkable abnormality was observed, a double shell in which the oral end of a typical *L. squamoso-sulcata* was joined to the base of a specimen of *L. costata*. Such abnormalities are evidence of the trifling zoological importance attributable to specific distinctions in the Foraminifera. Wiesner records this species (W. 1931, FDSE, p. 119, pl. xxiii, Stereo-fig. *h*), but his photographic figure is not clear. He also records a new species *L.* (*Entosolenia*) *scalariforme-sulcata* (W. 1931, FDSE, p. 120, pl. xviii, fig. 219). Both the description and figure appear to agree with *L. squamoso-sulcata.*

397. **Lagena staphyllearia** (Schwager) (F. 224) (SG 245).

Six stations: 180, 384, 385; WS 205, 403, 506.

Single specimens only except at St. 385, where two were recorded. The specific name is very loosely used for any compressed form with spinous base, but Schwager's type is fairly distinctive. It represents a somewhat compressed but non-carinate form, with three rather prominent equally-spaced basal spines. The type occurs at St. 385 with the typical three spines, at St. WS 403 with the middle spine almost suppressed, and at St. WS 506 with the two outer spines only. At the remaining stations the specimens are zoologically *L. marginata* with basal spines. The test is compressed, more or less distinctly carinate, and the basal spines vary between three and five in number.

398. **Lagena stelligera**, Brady.

Lagena stelligera, Brady, 1879, etc., RRC, 1881, p. 60; 1884, FC, p. 466, pl. lvii, figs. 35, 36.
Lagena stelligera, Cushman, 1910, etc., FNP, 1913, p. 26, pl. xii, fig. 3.
Lagena stelligera, Sidebottom, 1912, etc., LSP, 1912, p. 391, pl. xv, figs. 28, 29; pl. xvi, figs. 1–4; 1913, p. 174.

Four stations: 383, 385, 386; WS 469.

Very rare everywhere. All the stations are in deep water. This is a most variable species, the range of form being well illustrated by Sidebottom. At St. 383 a single specimen exactly like Brady's type figure; at St. WS 469 a practically identical specimen but without the basal costae; at St. 386 these two forms occur together; at St. 385 the type is long and slender, very like Sidebottom's fig. 29 (*ut supra*).

399. **Lagena stelligera var. eccentrica**, Sidebottom.

Lagena stelligera var. *eccentrica*, Sidebottom, 1912, etc., LSP, 1912, p. 392, pl. xvi, figs. 5, 6; 1913, p. 175, pl. xv, fig. 30.
Lagena stelligera var. *excentrica*, Heron-Allen and Earland, 1922, TN, p. 148.

Three stations: 384, 385, 386.

One specimen only at Sts. 384 and 385, and two at St. 386.

In this variety the basal collar is replaced by a more or less inconspicuous ring of solid shell substance encircling the base of the test. The shape of the ring according to Sidebottom is variable, hence presumably the varietal name. In the Discovery specimens the ring is always circular, generally prominent, notably at Sts. 385 and 386. At the latter station two specimens were found, in one of which the base was prolonged into a short blunt spine in the centre of the ring.

400. **Lagena stelligera var. nelsoni**, Heron-Allen and Earland.

Lagena stelligera var. *nelsoni*, Heron-Allen and Earland, 1922, TN, p. 148, pl. v, figs. 20–22.

Two stations: 175; WS 482.

Some very good and typical examples at St. WS 482. At St. 175 only a single abnormal specimen, which has not the usual beak, turned sideways and containing the aperture. The aperture is at the side of the test where the beak should be.

401. **Lagena stewartii**, J. Wright (F 171) (SG 246).

One station: WS 204.

Only a single specimen was recorded from 3328 m.; it is probable that it occurs at other stations but was not separated from *L. globosa*.

402. **Lagena striata** (d'Orbigny) (F 188) (SG 247) (Plate VII, figs. 29, 30).

Thirteen stations: 180, 191, 196, 383–6; WS 205, 403, 468, 469, 485, 506.

Rare or very rare everywhere, most frequent at Sts. 385 and 386. With a single exception all the specimens are of the elongate form figured by Williamson; in some cases, notably at Sts. 383 and WS 403, the specimens are very long with almost parallel sides. The true d'Orbigny type with spherical test and long neck does not occur at all, but at St. WS 469 a single specimen was found which is perhaps a modification of the type. It is large, and has an almost globular body covered with very regular but faint striae. The neck is short, very solid and covered with weak costae, formed by the extension of some of the striae from the body of the test. It is altogether a very striking variety and is figured. It comes from a great depth, 3959 m.

403. **Lagena striata** var. **strumosa**, Reuss.

Lagena strumosa, Reuss, 1858, FP, p. 434.
Lagena strumosa, Reuss, 1862 (1863), FFL, p. 328, pl. iv, fig. 49.
Lagena striata var. *strumosa*, Cushman, 1910, etc., FNP, 1913, p. 20, pl. vii, figs. 7–10.

Three stations: 384, 386; WS 403.

A single specimen of this apiculate variety was found at each station.

404. **Lagena striato-punctata**, Parker and Jones, var. **complexa** Sidebottom.

Lagena striato-punctata, var.n. *complexa*, Sidebottom, 1912, etc., LSP, 1912, p. 393, pl. xvi, fig. 11; 1913, p. 176.

One station: WS 469.

A single specimen from 3959 m. in the Drake Strait. It has a long delicate neck and about twenty prominent costae bearing inconspicuous tubules. The intercostal grooves are deep and granular in appearance. It is referred with some hesitation to Sidebottom's variety, neither the figure nor the description being very distinct.

405. **Lagena sulcata** (Walker and Jacob) (F 189) (SG 248).

Twelve stations: 170, 175, 200, 363, 383–6; WS 204, 205, 468, 507B.

Usually rare or very rare, but frequent and variable at St. 385, though all the specimens were small. Large and typical examples at Sts. 170, 175 and 200. A large globular specimen with short thick neck and spinous base at St. WS 204, and a typical specimen with very long neck at St. WS 507B. The variety *interrupta*, Williamson, was recorded at St. 363 and probably occurs at other stations, but was not regarded as worthy of separation. At St. 384 the species was exceptionally variable; in addition to the type, specimens running into *L. gracilis* and *L. acuticosta* were noted.

406. Lagena sulcata var. apiculata, Cushman.

Lagena sulcata, apiculate forms, Brady, 1884, FC, pl. lviii, figs. 4, 17.
Lagena sulcata var. *apiculata*, Cushman, 1910, etc., FNP, 1913, p. 23, pl. ix, fig. 3, (? 4); 1918, etc., FAO, 1923, p. 58, pl. xi, fig. 2.

Four stations: 386; WS 205, 403, 468.

Only a single specimen at each station but all very strongly spinous at the base; the best at St. WS 468.

Cushman's description (1910) of his variety, which is not uncommon in deep water, is "Test like typical *L. sulcata*, but the apical end drawn out into a stout spine; aperture rounded". Of the two specimens figured only one (fig. 3) seems referable to *L. sulcata*. Fig. 4 appears to be quite distinctive in the arched loops separating the main costae.

407. Lagena texta, Wiesner (Plate VII, figs. 31–35).

Lagena texta, Wiesner, 1931, FDSE, p. 121, pl. xix, fig. 230.

Four stations: 170, 175, 200; WS 482.

This large and striking species was described by Wiesner from a single specimen found in 385 m. off Kaiser Wilhelm's Land (66° 2′ S, 89° 38′ E). His description is hardly sufficient for identification, and the figure, taken as he explained to me from a "dark field photograph of the dry specimen", lacks detail. I therefore sent him some Discovery specimens, and he has been good enough to confirm their identity.

A full description of the species seems desirable: test flask-shaped, triangular in section; narrow at the oral end which is surmounted by a short phialine neck bearing the aperture; the test increases rapidly in breadth for quite two-thirds of its length, then gradually decreases to the base, which is rounded.

The three edges of the test are produced into flat cellular wings with truncate margins. These wings are broadest where they meet round the base, and taper away towards the oral end, where they become merged into the facial surfaces below the neck. The three facial surfaces are slightly convex and double-walled, the stout internal wall being covered with low ramifying costae, over which is a delicate and hyaline outer shell. The spaces between the costae form cellules, irregularly fusiform in shape, like the pulp cells of an orange. Their silvery lustre, due to the air contained in them, contrasts strongly with the darker hyaline costae. Wiesner describes the shell as "ornamented with a network of irregular elongate-squared meshes". He does not mention the double wall, but in his letter he agrees as to its presence.

The facial surfaces of the test are sometimes separated from the cellular wing by a trough, which is broadest round the base of each face, and is due to an interruption of the cellular structure. The width of the wing is variable; it is apparently a solid structure, pierced by numerous large tubules which open on the truncate margin of the wing.

Length up to nearly 0·60 mm.; greatest breadth and thickness up to 0·25 mm.

L. texta appears to have a very limited distribution in our material, being confined to a few stations in the Bransfield Strait and northwards to Clarence Island. It is not infrequent at St. WS 482 in 100 m., where the best series was obtained. The greatest depth recorded was 345 m. at St. 200.

Its normally triangular shape is noteworthy, as it is almost unknown in the genus, if we except the abnormal trigonal condition occasionally assumed by many compressed species of *Lagena*. It is of particular interest therefore to record the occurrence at St. 175 of an abnormal specimen of *L. texta*, a compressed individual with two faces only, thus reversing the usual lines of variation. A specimen with four faces was found at the same station.

From its occurrence at points almost diagonally opposite on the coastline of Antarctica, the species may probably have a circumpolar distribution.

408. **Lagena torquata**, Brady (Plate VI, fig. 43).

Lagena torquata, Brady, 1879, etc., RRC, 1881, p. 62; 1884, FC, p. 469, pl. lviii, fig. 41.
Lagena torquata, Cushman, 1910, etc., FNP, 1913, p. 27, pl. xi, fig. 3.

Two stations: 385, 386.

A single large but rather weakly marked specimen from St. 386, 4773 m., and two good specimens from St. 385, 3638 m., both in the Drake Strait.

409. **Lagena ventricosa**, A. Silvestri (SG 249) (Plate VII, figs. 36, 37).

Eight stations: 384–6; WS 204, 205, 403, 468, 469.

All the stations are in very deep water between 3328 and 4773 m. The specimens are thick-walled, generally opaque, but at St. 385 there was a large and typical hyaline specimen which exhibited an entosolenian tube attached and reaching almost to the base of the shell. There is great variation in the size and development of the hood, which appears to come into existence by the suppression of one side of a produced fissurine mouth, the other side becoming more or less curved. This origin seems to be confirmed by the fact that many of the specimens, notably at Sts. 384, WS 204 and 469, are somewhat compressed, being inseparable, except for the developing hood, from specimens of *L.* (*Fissurina*) *globosa*. These compressed specimens may be identical with *L.* (*Entosolenia*) *marginata* var. *ventricosa* (Wiesner, 1931, FDSE, p. 120, pl. xix, fig. 222). Wiesner describes his variety as nearly spherical, not much flattened at the sides, having on the periphery a weak ring standing out more strongly at the apertural end. His photographic figure is far from distinct.

A single specimen from St. 384 is perhaps an exaggerated example of his variety. It is pear-shaped, compressed, broadest at the base, which has a distinct carina not extending over the upper half of the test. The hood is greatly extended and flattened out. We figure the specimen, which is very distinctive, but in the absence of others do not consider it worth varietal distinction.

410. **Lagena vilardeboana** (d'Orbigny) (F 191).

Two stations: 384, 385.

A single weak specimen at each station.

411. **Lagena virgulata**, Sidebottom (Plate VII, figs. 38, 39).

Lagena laevigata, var.n. *virgulata*, Sidebottom, 1912, etc., LSP, 1912, p. 400, pl. xvii, fig. 8; 1913, p. 181, pl. xvi, fig. 6.
Lagena acuta, var.n. *virgulata*, Sidebottom, 1912, etc., LSP, 1912, p. 401, pl. xvii, fig. 10; 1913, p. 182.

Five stations: 384–6; WS 204, 205.

Very rare, only one or two specimens at each station, the best at Sts. 386 and WS 204, 205. Sidebottom speaks of his variety *virgulata* as characterized by "four small narrow opaque markings on the test, two on either face....I think they are sometimes just raised above the surface". He applies the varietal name to both *L. laevigata* and *L. acuta*. With one exception (at St. 385) there can be no doubt that in the Discovery specimens the so-called markings are slits in the shell. I cannot say whether they communicate with the interior, but they appear from their position and nature to be homologous with the loops or pockets of *L. alveolata*, and to indicate relationship to that group. I have therefore raised Sidebottom's variety to specific rank.

Sub-family *NODOSARIINAE*

Genus Nodosaria, Lamarck, 1812

412. **Nodosaria rotundata** (Reuss) (F 247) (SG 251).

Four stations: 170, 175, 181; WS 482.

Very good specimens were frequent at St. 175, mostly typical, but one is rather elongate, and approaches Brady's figure of *Nodosaria aequalis* (Reuss) (B. 1884, FC, pl. lxi, fig. 52), though not sufficiently to be referred to that species.

N. rotundata is rare at Sts. 170 and 181, and at St. WS 482 only a single small specimen was found in 50 m.; this is the shallowest record, the deepest being 342 m. at St. 170.

413. **Nodosaria calomorpha**, Reuss (F 252) (SG 254).

Eight stations: 203, 363, 385, 386; WS 468, 482, 485, 506.

Very rare, never more than one or two specimens at each station, and none with more than three chambers. The best specimens were found at the deep-water stations 385, 386 in the Drake Strait, and outside or near the Antarctic convergence line.

414. **Nodosaria consobrina**, d'Orbigny (SG 255).

One station: 386.

A single small specimen from 4773 m. in the Drake Strait, outside the Antarctic convergence line.

415. **Nodosaria communis**, d'Orbigny (F 254) (SG 256).

Eight stations: 363, 384–6; WS 205, 403, 468, 469.

Only single specimens except at Sts. 384, 385, 386, WS 403, and the species is rare even at these stations. With the exception of a single specimen at St. 363 in the South Sandwich Islands (329 m.), all the records are from deep water in the Scotia Sea and Drake Strait, 3638–4773 m., and three of the stations are outside the Antarctic convergence line. At St. 384 the specimens are weakly marked, approaching a variety *larva* which I am separating from the type species.

416. **Nodosaria communis var. larva**, var.n. (Plate VII, figs. 40, 41).

Two stations: 385; WS 482.

Very rare at both stations which are widely separated and vary greatly in depth, St. 385 being in the middle of the Drake Strait (3638 m.) and WS 482 in the Bransfield Strait (100 m.).

The variety agrees with the type species in structure, but the outer or aboral edge of each chamber is marked by a curious saddle-shaped patch, extending over part of the sides of each chamber. The mark may be due to a thickening of the wall of the test. In the earliest formed chambers the mark is white, fixed and visible at any angle of illumination. In later chambers it is only white when illuminated at a particular angle, at other angles quite hyaline, though visible. Both megalospheric and microspheric specimens were found with the marks, which give the test a certain fanciful resemblance to a caterpillar, whence the varietal name.

Length varies up to 1·1 mm.

417. **Nodosaria mucronata**, Neugeboren.

Nodosaria (*Dentalina*) *obliqua*, d'Orbigny (*non* Linné), 1826, TMC, p. 254, no. 36; Modèle, no. 5.
Dentalina mucronata, Neugeboren, 1856, OLS, p. 83, pl. iii, figs. 8–11.
Nodosaria mucronata, Reuss, 1870, FSP, p. 475, no. 30; S. 1870, FSP, pl. ix, fig. 27; pl. xxxviii, fig. 6.
Nodosaria mucronata, Brady, 1884, FC, p. 506, pl. lxii, figs. 27–9.

One station: 385.

Only a single specimen, found at St. 385 in the Drake Strait. This station is in 3638 m. and inside but near the Antarctic convergence line.

418. **Nodosaria pauperata** (d'Orbigny) (F 255) (SG 257).

Thirteen stations: 170, 175, 180, 181, 186, 196, 363, 383; 64° 56′ S, 64° 43′ W; WS 403, 482, 483, 494A.

The stations are widely separated over a large area, from the South Sandwich group to the Drake Strait, through the South Orkneys, South Shetlands and Palmer Archipelago. The species never occurs with any frequency, but very large specimens were observed at Sts. 175, 181, 363, both megalospheric and microspheric forms being found at each of these stations. As usual the megalospheric form predominates except at St. 181, where the microspheric form was frequent, and the megalospheric very rare. At St. WS 482 in the Bransfield Strait in shallow water (100–152 m.) the specimens were megalospheric but comparatively small and pauperate, the tests being translucent. The range of depth extends between 100 and 3744 m., but all the best specimens were found in moderate depths.

419. **Nodosaria inflexa**, Reuss.

Nodosaria inflexa, Reuss, 1865–6, FABS, p. 131, pl. ii, fig. 1; 1870, FSP, p. 472, no. 16; von Schlicht, 1870, FSP, pl. xxxviii, fig. 3.
Nodosaria inflexa, Brady, 1884, FC, p. 498, pl. lxii, fig. 9.
Nodosaria inflexa, Cushman, 1921, FP, p. 191.

One station: 385.

A single specimen from 3638 m.

420. **Nodosaria obliqua (Linné).**

Nautilus obliquus, Linné, 1767, etc., SN, edition 12, 1767, p. 1163, 281; edition 13 (Gmelin), 1788, p. 3372, no. 14.
Nodosaria obliqua, Brady, 1884, FC, p. 513, pl. lxiv, figs. 20–2.
Nodosaria obliqua, Goës, 1894, ASF, p. 70, pl. xii, figs. 691–6.

One station: 170.

Two very fine specimens, one megalospheric and the other microspheric, were found at St. 170, Clarence Island, 342 m.

421. **Nodosaria raphanistrum (Linné) (Plate VII, figs. 42, 43).**

Nautilus raphanistrum, Linné, 1767, etc., SN, 13th ed. (Gmelin), 1788, p. 3372.
Nodosaria raphanistrum, Parker and Jones, 1859, etc., NF, 1859, p. 478; 1871, p. 156, pl. ix, fig. 41.
Nodosaria raphanistrum, O. Silvestri, 1872, NFVI, p. 27, pl. i, figs. 1–19.
Nodosaria raphanistrum, Heron-Allen and Earland, 1922, TN, p. 171.

Three stations: 384–6.

Extremely rare at these stations, which are all in the deep water of the Drake Strait.

The small form figured has little in common with the gigantic specimens found in some of the European tertiary deposits, which attain a length of more than an inch. But they have the really specific feature in their approximately equal diameter throughout, and the discontinuous but parallel costae. The largest specimen, found at St. 384, has six chambers, but most of the others only three or four. They all agree in having a proloculus wider than the subsequent chambers, and a final chamber narrower than its predecessor and with a truncate extremity bearing a very small central aperture. This last feature marks their pauperate condition.

It would no doubt have been possible, given the time, to find a figure more or less resembling the specimens among the hundreds of illustrations available; or failing that to add yet another species to the already swollen list of *Nodosariae*. But I regard them merely as highly pauperate individuals, and have listed them under the zoological species to which I think they belong.

Length of a four-chambered specimen 0·36 mm.

N. raphanistrum was recorded by the Terra Nova Expedition from the New Zealand area and from the Antarctic (H.-A. and E. 1922, TN, p. 171, no. 403). The New Zealand specimen was typical, but those from the Antarctic stations 23, 27, 36 were identical with the Discovery specimens. It would therefore appear that this pauperate form is widely distributed in southern waters.

Genus Lingulina, d'Orbigny, 1826

422. **Lingulina vitrea, Heron-Allen and Earland (F 264) (SG 258).**

Two stations: 175, 190.

Two typical specimens at St. 190 to the south of the Palmer Archipelago, in 130 m., and a single specimen at St. 175 in the Bransfield Strait, 200 m. This last-mentioned specimen is far from typical, the four chambers following the proloculus increasing in width much more rapidly than usual, but in the absence of further examples it was not thought worthy of separation.

Genus Vaginulina, d'Orbigny, 1826

423. **Vaginulina legumen** (Linné) (F 265) (SG 259).

Four stations: 170, 363, 385; WS 482.

Very rare at all stations. The specimens are of average size but very thin-walled and flattened, except the specimen from St. 385.

Genus Cristellaria, Lamarck, 1812

424. **Cristellaria crepidula** (Fichtel and Moll) (F 268) (SG 262).

One station: 170.

Only a single very fine megalospheric specimen was found.

425. **Cristellaria acutauricularis** (Fichtel and Moll) (F 270).

Two stations: 383, 385.

A single good specimen at each of these deep-water stations in the Drake Strait.

426. **Cristellaria lata** (Cornuel) (F 273).

One station: 170.

Two large specimens were found at St. 170, off Clarence Island, midway between the South Orkneys and the South Shetlands, in a depth of 342 m.

427. **Cristellaria obtusata**, Reuss (F 272) (Plate VII, figs. 46, 47).

Two stations: 170, 177.

A single excellent specimen at each station.

428. **Cristellaria subarcuatula** (Montagu) (Plate VIII, figs. 1, 2).

Nautilus subarcuatulus, Montagu, 1803–8, TB, Supplement 1808, p. 80, pl. xix, fig. 1.
Cristellaria calcar, marginuliniform specimen, P. and J., 1857, FCN, p. 291, pl. x, figs. 1, 2.
Cristellaria subarcuatula, Goës, 1894, ASF, p. 63, pl. xi, figs. 630–7.

Three stations: 170, 363; WS 468.

Rare at all stations. Large and excellent examples at St. 170. Montagu's type is uncertain; according to Parker and Jones (P. and J. 1859, etc., NF, 1859, p. 349) it may have been a fossil from the Thanet Sands. But the name has long been associated with the form figured by those authors from Norway (1857).

429. **Cristellaria saulcyi**, d'Orbigny (Plate VII, figs. 48, 49).

Cristellaria saulcyi, d'Orbigny, 1839, FIC, p. 126, pl. iii, figs. 7–9.
Cristellaria saulcyi, Goës, 1894, ASF, p. 63, pl. xi, figs. 623–9.

One station: 177.

A single very large specimen from 1080 m. in the South Shetlands is, I think, assignable to this species. It lacks the few costae on the early chambers shown in d'Orbigny's original figure, but not in those of Goës.

430. **Cristellaria compressa**, d'Orbigny (Plate VII, figs. 44, 45).

Cristellaria compressa, d'Orbigny, 1846, FFV, p. 86, pl. iii, figs. 32, 33.

One station: 385.

The single specimen from 3638 m. in the Drake Strait, which is figured, appears to be near d'Orbigny's original figure and description. D'Orbigny's species was from the Miocene of Baden. The subsequent figures of Brady (B. 1884, FC, p. 538, pl. cxiv, figs. 15, 16) and Flint (F. 1899, RFA, p. 315, pl. lxii, fig. 1) represent a different organism.

The specimen is 0·80 mm. long.

431. **Cristellaria gibba**, d'Orbigny (F 274) (SG 263).

Eleven stations: 170, 175, 180, 384–6; WS 403, 469, 481, 482, 513.

Very rare everywhere; most frequent at St. 170, where very good specimens were found, also fossils. Single very good specimens also at Sts. WS 469 and 482. The stations are scattered over the entire area except the Weddell Sea, and show a great range of depth between 100 m. at St. WS 482 and 4773 m. at St. 386. The specimens from the deeper stations are generally very small.

432. **Cristellaria rotulata** (Lamarck) (F 276).

Seven stations: 170, 175, 363, 386; WS 469, 482, 507B.

Only a single specimen at each station, the best at St. 363 in the South Sandwich Islands, 329 m., and at St. WS 507B in the Bellingshausen Sea, 580 m.

433. **Cristellaria cultrata** (Montfort) (F 278) (SG 264).

Three stations: 385; WS 403, 507A.

Only a single specimen at each station, the best at St. 385, 3638 m., in the Drake Strait.

434. **Cristellaria articulata** (Reuss) (F 279).

One station: 170.

A single good specimen of the regular type was found at a depth of 342 m., off Clarence Island.

435. **Cristellaria crassa**, d'Orbigny (F 280).

Two stations: WS 505, 507B.

Two very good specimens at St. WS 507B, and a smaller specimen at St. WS 505. Both stations are in the Bellingshausen Sea.

436. **Cristellaria convergens**, Bornemann (F 281) (SG 265).

Three stations: 383–5.

Single specimens were found at these three deep-water stations in the Drake Strait, inside the convergence.

437. **Cristellaria angulata** (Reuss) (F 282).

One station: 363.

A single specimen, similar to those figured from the Falkland Islands area, was found at St. 363 in the South Sandwich Islands, at a depth of 329 m.

Sub-family *POLYMORPHININAE*

Genus **Glandulina**, d'Orbigny, 1826

438. **Glandulina laevigata**, d'Orbigny (F 248) (SG 252).

Five stations: 170, 175, 181, 196; WS 482.

Except at St. 175 in the Bransfield Strait (200 m.), where the species is frequent and well developed, specimens are rare or very rare. The stations are confined to the small area between Clarence Island, which is midway between the South Orkneys and the South Shetlands, and the Palmer Archipelago to the south of the South Shetlands.

This species, which for over a century has been regarded as a *Nodosaria*, must now be transferred to the Polymorphininae, in consequence of Ozawa's discovery that the microspheric form is biserial in the early stage.

Genus **Polymorphina**, d'Orbigny, 1826

439. **Polymorphina lactea** (Walker and Jacob) (F 283) (SG 266).

One station: 384.

Two small specimens were found at St. 384 in the Drake Strait, depth 3713 m.

440. **Polymorphina williamsoni**, Terquem (F 285) (SG 267).

One station: 177.

A single small but typical specimen was found at St. 177 in the Bransfield Strait, depth 1080 m.

441. **Polymorphina ligua**, Roemer (F 292) (SG 268).

Polymorphina ligua, Roemer, 1838, CNTM, p. 385, pl. iii, fig. 25.
Polymorphina lingua, Reuss, 1855, TD, p. 248, pl. vii, fig. 77.
Polymorphina compressa, d'Orbigny (*non* Philippi), 1846, FFV, p. 233, pl. xii, figs. 32–4.
Polymorphina subcompressa, d'Orbigny, 1849, etc., PP, 1852, p. 159, no. 2976.
Pseudopolymorphina ligua, Cushman and Ozawa, 1930, P, p. 89, pl. xxii, figs. 5, 6.

Three stations: 164, 175, 190.

Very rare everywhere, and all small specimens except a single large individual at St. 175.

This species was listed in the previous reports as *P. compressa*, d'Orbigny. Under the rules of priority this name must give way to *P. ligua*, Roemer, an unfortunate change, particularly in view of the supersession of a name which has been in general use for three-quarters of a century, in favour of an orthographical error.

442. **Polymorphina sororia**, Reuss (F 286).

Two stations: 384, 385.

Small specimens are rare or very rare at these two stations, in the deep water of the Drake Strait.

443. **Polymorphina cylindroides**, Roemer.

Polymorphina cylindroides, Roemer, 1838, CNTM, p. 385, pl. iii, fig. 26.
Polymorphina cylindroides, Brady, Parker and Jones, 1870, P, p. 221, pl. xxxix, fig. 6.
Pyrulina cylindroides, Cushman and Ozawa, 1930, P, p. 56, pl. xiv, figs. 1–5.

Three stations: 384, 385; WS 403.

Extremely rare at all stations.

444. **Polymorphina fusiformis**, Roemer.

Polymorphina fusiformis, Roemer, 1838, CNTM, p. 386, pl. iii, fig. 37.
Polymorphina fusiformis, Brady, Parker and Jones, 1870, P, p. 219, pl. xxxix, fig. 5, and woodcut *e*.
Pyrulina fusiformis, Cushman and Ozawa, 1930, P, p. 54, pl. xiii, figs. 3–8.

Two stations: 385; WS 469.

Extremely rare, but a very good specimen at St. WS 469.

445. **Polymorphina angusta**, Egger (Plate VIII, figs. 3, 4).

Polymorphina angusta, Egger, 1857, MSO, p. 290, pl. xiii, figs. 13–15.
Polymorphina lanceolata (*pars*), Reuss, 1870, FSP, p. 487, no. 12; von Schlicht, 1870, FSP, pl. xxxi, figs. 2–4.
Polymorphina angusta, Brady, 1884, FC, p. 563, pl. lxxii, figs. 1–3.

Six stations: 384–6; WS 205, 403, 468.

Frequent at St. WS 403, where some of the specimens were slightly hispid, rare or very rare elsewhere, but identical with the form figured by Brady. This is a characteristic species in deep water, and appears to me to be identical with Egger's species.

P. angusta appears to have been overlooked in Cushman's and Ozawa's monograph. *P. angusta*, Brady *non* Egger, figures as a synonym of *P. fusiformis* (C. and O. 1930, P, p. 55), but the reference given is to Brady's figures of *P. sororia* var. *cuspidata*, which is also referred to in their text.

Brady's form is so constant and widely distributed in deep water that I think the name should be retained. He himself remarks that while originally of opinion that Egger's fossil was merely a variety of *P. fusiformis*, he had changed his view after studying a series of recent specimens.

446. **Polymorphina gibba**, d'Orbigny (F 287).

Four stations: 384–6; WS 403.

Very rare at all the stations, which are in the deep water of the Drake Strait. Single specimens only were found, except at St. 385. At St. 384 the specimen is fistulose.

In addition to these stations, a single specimen was found at St. 181 in the Palmer Archipelago, depth 160–335 m. It is clearly a fossil, a cast in calcite, and its significance must be considered in the light of the geological evidence contained in Macfadyen's report on the *Fossil Foraminifera from the Burdwood Bank* (M. 1933, FFBB). It is probably identical with the *Globulina gibba* var. *globosa* which he records.

447. **Polymorphina problema**, d'Orbigny (F 289).

One station: WS 403.

A single large and fistulose specimen was found at St. WS 403, depth 3721 m.

448. **Polymorphina extensa**, Cushman (Plate VIII, fig. 5).

Polymorphina lanceolata (*pars*), Reuss, 1870, FSP, p. 487, no. 12; von Schlicht, 1870, FSP, p. 82, no. 476, pl. xxxi, figs. 25–9.

Polymorphina longicollis, Brady (*non* Karrer 1870), 1879, etc., RRC, 1881, p. 64; 1884, FC, p. 572, pl. lxxiii, figs. 18, 19.
Polymorphina longicollis, Cushman (*non* Karrer), 1910, etc., FNP, 1913, p. 90, pl. xli, figs. 1–3.
Polymorphina extensa, Cushman, 1918, etc., FAO, 1923, p. 156, pl. xli, figs. 7, 8.
Pyrulina extensa, Cushman and Ozawa, 1930, P, p. 53, pl. xii, fig. 5 *a–c*.

Three stations: 385, 386; WS 403.

Very rare; all the stations are in the deep water of the Drake Strait, 3638–4773 m.

The specimens vary in roughness, some being typically hispid only on the final chamber, while others are hispid all over, as in Cushman's Pacific figure. Brady's original name, *P. longicollis*, must be abandoned, the specific name having been anticipated by Karrer for another form (K. 1870, KL, p. 181, pl. ii (xi), fig. 11).

449. **Polymorphina scoresbyana**, sp.n. (Plate VIII, figs. 6–8).

Three stations: 385, 386; WS 469.

The test consists of two distinct portions, the initial half being subglobular, and roundly oval in section, with entire margin and flush sutures, which are so indistinct that the chambers are hardly distinguishable. They appear to be arranged on a Globuline plan. Surface smooth but not polished. Superimposed is the final chamber, swollen and separated from the earlier portion of the test by a depressed sutural line. This final chamber varies in size but is always conspicuous, and sometimes equal in size to the whole of the remainder of the test. Its surface varies between smooth and unpolished and coarsely hispid. The aperture is situated at the end of a produced neck as in *P. extensa*.

Dimensions vary between 0·6–0·9 mm. in length, 0·35–0·45 mm. in breadth.

A single specimen at each of Sts. 386 and WS 469, both with the final chamber coarsely hispid; and two at St. 385, one feebly hispid on the final chamber, and the other smooth throughout. The distribution of *P. scoresbyana* in the Discovery material agrees generally with that of *P. extensa* (= *P. longicollis*, Brady *non* Karrer), to which species I think it is very closely allied, perhaps a mere variation. My sole reason for giving it a specific name is because under the revision of the genus *Polymorphina* by Cushman and Ozawa (C. and O. 1930, P) the two forms would fall into separate genera. The typical *Polymorphina longicollis* of Brady has become *Pyrulina extensa*, while under their classification *Polymorphina scoresbyana* would become *Globulina scoresbyana*.

Genus **Uvigerina**, d'Orbigny, 1826

450. **Uvigerina asperula**, Czjzek (F295).

Eight stations: 383–6; WS 403, 468, 469, 517.

Confined to the deep water of the Drake Strait, Scotia and Bellingshausen Seas between 2770 and 4773 m.; it is frequent or common except at Sts. 385 and 386. A very long form is found at Sts. 385, 386 and WS 403, in company with the normal type.

451. **Uvigerina aculeata**, d'Orbigny (SG 271).

Eight stations: 384–6; WS 204, 403, 469, 495, 503.

Common at St. WS 403, and frequent at Sts. 384, WS 204 and 469; rare elsewhere. No very typical specimens were found, most of them being more or less intermediate between *U. aculeata* and *U. pygmaea*.

452. **Uvigerina pygmaea**, d'Orbigny (F 297) (SG 270).

Six stations: 180, 383–5; WS 403, 468.

Common at St. WS 403, and frequent at St. 383, where the best specimens were found. Except St. 180 in 160 m., where only two specimens were seen, all the records are from deep water in the Drake Strait and Scotia Sea, 3638–4344 m.

453. **Uvigerina striata**, d'Orbigny (F 300) (SG 273).

Five stations: 196, 363, 366; WS 474, 498.

Very rare everywhere, generally a single specimen only.

454. **Uvigerina angulosa**, Williamson (F 301) (SG 274).

Fifty-one stations: 163, 164, 170, 175, 177, 180, 181, 187, 190, 194–6, 198, 200, 203, 363, 369, 385–7; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; WS 382, 393–5, 399, 468, 469, 474, 476, 482, 486, 488, 490, 493, 494A, 496–8, 505, 506, 507A, 507B, 510–5, 517.

Although so widely distributed, this species never attains a dominant position as in the Falklands area, in fact at the majority of stations it is very rare. The only stations where it is really common are Sts. 170, 175, 180, 200, 363, WS 505, 506, 507A, 507B, 514. There is the same wide range of variation as in the Falklands area. At the stations in the Bellingshausen Sea it attains very large dimensions, particularly at Sts. WS 505, 506, 507A, 507B. Most of the records are from moderate depths but they extend down to 4773 m.

455. **Uvigerina angulosa** var. **pauperata**, Heron-Allen and Earland (F 302).

Two stations: 386; WS 482.

A single specimen at each station.

Family GLOBIGERINIDAE

Genus **Globigerina**, d'Orbigny, 1826

Note. The abnormal specimens of *Globigerina* referred to in the South Georgia report, p. 120, and figured in that report on pl. iv, figs. 20–2, are found in some numbers in the Antarctic material. Notes have been kept of their occurrence at the following stations:

Station	Depth m.	No. of specimens	Species involved
177	1080	1	*G. pachyderma*
363	329–278	2	*G. dutertrei*
384	3713	13	*G. pachyderma, G. dutertrei*
386	4773	5	*G. pachyderma, G. inflata*
WS 204	3328	4	*G. conglomerata, G. pachyderma*
WS 403	3721	6	*G. conglomerata, G. pachyderma*
WS 469	4207	6	*G. inflata, G. pachyderma*
WS 498	398	1	*G. pachyderma*
WS 505	1500	8	*G. dutertrei*
WS 506	584	6	*G. inflata, G. pachyderma, G. dutertrei*
WS 507A	572	1	*G. pachyderma*

In the specimen from St. WS 498 the mouths of the two individuals are in contact, and though they are of dissimilar sizes, it may be a case of true plastogamy. If so I think it is the first recorded instance of plastogamy in the genus *Globigerina*.

As regards the other specimens, in which the two or more individuals, often of very dissimilar sizes, are fused together by their shell substance, but without proximity of apertures, it is still impossible to give any explanation of the phenomenon. But the possibility that they are plastogamic unions cannot be overlooked in view of the recent observations of E. H. Myers (M. 1933, MTF), who has established the existence of plastogamic union between individuals of very different sizes, and in groups of more than two individuals. In favour of this view is the fact that there is no miscegenation, the attached specimens are always of the same species.

456. **Globigerina bulloides**, d'Orbigny (F 304) (SG 276).

Twenty-five stations: 167, 170, 175, 180, 181, 190, 360, 363, 366, 384–7; WS 204, 205, 389, 395, 403, 468, 469, 471, 482, 505, 515, 517.

As might be expected, this species is most abundant at stations outside the Antarctic convergence line. Large specimens are more or less common at Sts. 384, 385, 386, WS 205, 403 and 469. But it is also widely distributed within the line, large specimens being common at St. 204 in the South Orkneys, and frequent at Sts. 170, 180, 190 and WS 482, all of which are affected by the warm Pacific water. At the remaining stations it is more or less rare, often very rare. Its range, however, extends to the extreme south of the Bellingshausen Sea, a few very good specimens having been found at St. WS 505, near the ice barrier.

457. **Globigerina triloba**, Reuss (F 305) (SG 277).

Twenty-four stations: 187, 200, 201, 384–7; WS 203–5, 391–3, 403, 468, 469, 471, 472, 474, 482, 486, 488, 515, 517.

Outside the Antarctic convergence line this species is frequent to very common at most of the deep-water stations, and the specimens are large and typical. Within the line it is common at St. WS 204 and frequent at St. 201; rare or very rare at the remaining stations, most of which are in deep water. The species was not recorded at all by Wiesner from Kaiser Wilhelm's Land, or in the Antarctic material of the Terra Nova Expedition, though it was found in the New Zealand area.

458. **Globigerina triloba**, Reuss, spinous var. (Plate VIII, figs. 13–15).

Two stations: 385; WS 204.

A few specimens were found at these deep-water stations in which the early chambers were covered with short strong spines. They are quite unlike the long and delicate spines found on pelagic *Globigerinae*. The largest specimen was about 0·40 mm. in diameter.

459. **Globigerina inflata**, d'Orbigny (F 306) (SG 278).

Eighteen stations: 170, 383–7; WS 204, 205, 392, 403, 468, 469, 471, 472, 502, 513, 517, 555.

Apart from single specimens found at Sts. 170, WS 392 and 513 which are under 600 m., the species is confined to the deepest water, where it is dominant at Sts. 385, 386, 387, WS 204, 205, 468 and 469. It is frequent at Sts. 384, WS 403 and 472; rare elsewhere. Thin-walled pelagic specimens were seldom seen, the general form being smooth, thick-walled and benthic. At some stations, notably St. WS 205, small specimens become quite rounded owing to the thickness of the wall and diminished size of the aperture, and are very similar to *G. pachyderma*, which is also very abundant and variable at that station.

460. **Globigerina dutertrei**, d'Orbigny (F 307) (SG 279).

Forty-two stations: 164, 167, 170, 175, 177, 180, 181, 195, 196, 200, 201, 363, 366, 369, 383–7; Port Lockroy; WS 204, 385, 389, 391–3, 468, 469, 481–3, 490, 493, 498, 502, 505, 506, 507A, 507B, 510, 513, 517.

Generally distributed and very common at Sts. 384–6 and WS 469. It is also common at Sts. 170, WS 204 and 517 and frequent at eleven other stations, 175, 195, 201, 363, WS 392, 481, 482, 505, 506, 507A and 507B. Elsewhere generally very rare. There is great variation in size, also in the height of the spire and size of the aperture, all of these tending to produce specimens running into *G. pachyderma*.

461. **Globigerina conglomerata**, Schwager (F 308) (SG 280).

Forty-six stations: 167, 170, 175, 177, 180, 181, 186, 187, 190, 196, 199, 200, 201, 363, 366, 369, 384–7; 62° 57′ S, 60° 20′ 30″ W; WS 202–5, 387, 392, 394, 395, 403, 468, 469, 472, 474, 479, 481–3, 485, 496, 505, 506, 507A, 507B, 514, 517.

Generally distributed but not abundant except at a few stations. It is very common at Sts. 170, 385 and 387, WS 204, 403, 468, 469, 505, 506, 507A, 507B, and at the last four of these stations, which are in the Bellingshausen Sea, it is the dominant species. At the remaining stations it varies from moderate frequency to very rare. There is great variation in size at different stations, and also in the nature of the aperture, which is sometimes very large and open, at others more or less closed by a projecting flap of the final chamber. From this last condition specimens pass almost imperceptibly into the large thin-walled type of *G. pachyderma*.

462. **Globigerina elevata**, d'Orbigny (F 312) (SG 284).

Five stations: 180, 385; WS 204, 205, 393.

Very common, except at Sts. WS 205 and 393 where it is rare.

Wiesner (W. 1931, FDSE, p. 133) proposes the new name *G. bradyi* for this small form, which has been recorded from many localities under the names of various species of *Globigerina*, *G. rubra*, *G. elevata*, *G. trochoides*. The suggestion seems good, as it appears to be a true species and does not approach very closely to any of the foregoing species. I am, however, retaining the name under which it has been recorded previously in this series of reports.

463. **Globigerina megastoma**, sp.n. (Plate VIII, figs. 9–12).

Four stations: 385; WS 204, 403, 469.

Test large and very thin-walled: a trochoid spiral of about 2½ convolutions, all visible on the dorsal side; the last convolution only is visible on the ventral side, which is deeply recessed. The aperture, situated on the inner edge of the final chamber, is large and semicircular, with a reverted lip. The chambers, which are greatly inflated, increase rapidly in size, the sutures being deeply depressed; four chambers do not quite complete the final convolution. The surface is almost smooth, not areolated, but covered with a number of minute tubercles, which presumably support spines in the living animal. Colour white, rather glassy.

Maximum breadth of final convolution about 0·60 mm.; height measured from apex to lowest point of final chamber about 0·50 mm.

This rather striking species occurs at four stations only, all in the deep water of the Drake Strait and Scotia Sea, 3328–3959 m. Two of the stations, 385 and WS 469, are just on the Antarctic convergence line, and the others within it. It is very rare, three specimens at Sts. WS 204, 403, one at St. WS 469, and seven at St. 385. From the large size of the aperture and the thinness of the shell it is almost certainly a pelagic species, and probably of South Pacific habitat. Its affinities appear to be with *G. dutertrei*, d'Orbigny, from which it differs in its greater size, the greater height of its spire, its much larger aperture, and a lesser number of chambers.

The outline figure drawn by Fornasini (F 1898, GFI, p. 209, fig. 4) from d'Orbigny's "Planche inédite" of *G. helicina* is very suggestive of *G. megastoma*, but cannot represent the same species. See note on the type of *G. helicina* in the Falklands report, p. 401.

464. **Globigerina pachyderma** (Ehrenberg) (F 310) (SG 281).

Eighty-four stations: 162, 167, 170, 175, 177, 180, 181, 182, 186, 187, 190, 192, 194–6, 200, 202, 203, 360, 362, 363, 366, 369, 382–7; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; Port Lockroy; WS 202–5, 382–5, 389, 391–3, 395, 396, 403, 468, 469, 471, 472, 474–6, 479, 480, 482, 483, 485–8, 493, 494A, 495–8, 502, 505, 506, 507A, 507B, 509–17, 553, (555 fossils).

Almost universally distributed and irrespective of depth, the records ranging from 93 to 4773 m. It is the dominant form at Sts. 384, 385, 386, WS 205, 403 and 507B, all of which except the last are in deep water. It is also very common at Sts. 170, 175, 180, 369, 383, 387, WS 204, 468, 469, 472, 482, 498, 505, 511, 512 and 517, and although many of these stations are in deep water others are shallow, as St. WS 482, 100–0 m. Depth therefore does not appear to affect its distribution or numbers very greatly. At many of the stations it is extremely rare, though common under similar conditions at another station not far away. There is great variation in size and in the nature of the aperture, and at many stations it is possible to obtain a series of specimens showing the transition from thin-shelled and hyaline forms with large arched apertures, to the thick-shelled nearly globular forms, in which the chambers are almost unrecognizable and the aperture is reduced to a central hole. Fossil specimens were not infrequent at St. WS 555.

Genus **Orbulina**, d'Orbigny, 1826

465. **Orbulina universa**, d'Orbigny (F 314) (SG 285).

One station: WS 403.

A few dead shells, possibly current-borne, at St. WS 403 in the Drake Strait.

Genus **Hastigerina**, Wyville Thomson, 1876

466. **Hastigerina pelagica** (d'Orbigny).

Nonionina pelagica, d'Orbigny, 1839, FAM, p. 27, pl. iii, figs. 13, 14 on plate; figs. 1, 2 in text incorrect.

Hastigerina murrayi, Wyville Thomson, 1876, in M. 1876, PRC, p. 534, pls. xxii, xxiii.
Hastigerina pelagica, Brady, 1879, etc., RRC, 1879, p. 291; 1884, FC, p. 613, pl. lxxxiii, figs. 1–8.
Hastigerina pelagica, Cushman, 1918, etc., FAO, 1924, p. 33, pl. vi, figs. 1–8.

One station: 161.

A single fine specimen which had evidently sunk recently from the surface water, as it shows no sign of erosion. St. 161 is in the deep water (3459 m.) of the Scotia Sea in lat. 57° 21′ 20″ S, which is probably the most southerly record for the species.

Genus **Pullenia**, Parker and Jones, 1862

467. **Pullenia sphaeroides** (d'Orbigny) (F 315) (SG 286).

Forty-five stations: 170, 171, 175, 177, 181, 187, 192, 196, 202, 203, 360, 363, 369, 383–6; 62° 57′ S, 60° 20′ 30″ W; 64° 56′ S, 64° 43′ W; Port Lockroy; WS 204, 205, 383, 385, 393, 403, 468, 469, 482, 483, 485–7, 494A, 494B, 496, 497, 505, 507A, 507B, 509, 511, 512, 515, 517.

Frequent at Sts. 177, 384, 385, WS 403, 483, 486, the depths ranging between 787 and 3721 m. It was rare or very rare at the remaining stations, which are of varying depths down to 4773 m. at St. 386, where the few specimens were very large and of the typical spherical form. As usual varying degrees of lateral compression were observable, often at the same station; this does not appear to be influenced by depth, although the spherical form reaches its finest development at the deepest stations 383, 384, 385, 386, WS 204, 403, 468, at none of which was the compressed form noticed.

468. **Pullenia subcarinata** (d'Orbigny) (F 316) (SG 287).

Thirty-seven stations: 167, 170, 175, 177, 180–2, 186, 187, 190, 194–6, 198, 200, 363, 366, 369, 383–6; 64° 56′ S, 64° 43′ W; WS 205, 382, 403, 468, 469, 482, 488, 490, 493, 494A, 499, 505, 509, 513.

Generally distributed and at all depths; common at Sts. 170 and 175 which are in moderate depths, 200–342 m., and at WS 403 in 3721 m.; frequent at Sts. 177, 180, 181, 363 and 366, the depths of which range between 160 and 1080 m.; rare or very rare at the remaining stations. There are very few records in the Bellingshausen Sea. Typical *P. subcarinata* is the general form everywhere, but there is considerable variation in the inflation of the chambers. Specimens with inflated chambers giving a lobulate periphery were observed at Sts. 170, 180, 383, 384, WS 468 and 469. Other compressed specimens answering to *P. quinqueloba* (Reuss) were seen at Sts. 180, 383, 384, 385, WS 205, 403, 468 and 469; they were always small as compared with *P. subcarinata* at the same stations.

Genus **Sphaeroidina**, d'Orbigny, 1826

469. **Sphaeroidina bulloides**, d'Orbigny (SG 289).

Eight stations: 180, 383, 384–6; WS 468, 469, 472.

Single specimens at Sts. 180 and WS 472, rare or very rare elsewhere. All the tests are small but quite typical. The record at St. 180 in the Palmer Archipelago (about 64° 22′ S) is a notable extension of the southern limit of this species, the previous record being the specimen recorded in the South Georgia report from St. WS 522 in 52° 56′ S. But there can be no doubt that all the present records are due to the inflow of warm Pacific water through the Drake Strait, as proved by the increasing rarity of specimens, and some diminution in their size as the higher latitudes are reached; also the entire absence of the species in the Weddell Sea.

Family ROTALIIDAE

Sub-family *SPIRILLININAE*

Genus Spirillina, Ehrenberg, 1841

470. **Spirillina vivipara**, Ehrenberg (F 319) (SG 290).

One station: WS 482.

Three small specimens from 50 m. at St. WS 482.

471. **Spirillina wrightii**, Heron-Allen and Earland (Plate VIII, figs. 18, 19).

Spirillina margaritifera (*non* Williamson), Terquem, 1875, etc., APD, 1881, p. 110, pl. xiii, fig. 2 *a*, *b*.
Spirillina margaritifera (*non* Williamson), Wright, 1885–6, BLP, p. 321, pl. xxvi, fig. 12 *a*, *b*.
Spirillina margaritifera (*non* Williamson), Halkyard, 1889, RFJ, p. 69, pl. ii, fig. 7.
Spirillina wrightii, Heron-Allen and Earland, 1930, FPD, p. 181, pl. iv, figs. 54–8.

One station: 170.

A few specimens were found at St. 170, Clarence Island, in 342 m. *Spirillina tuberculata*, Brady, also occurs at this station, and until young specimens of that species exactly resembling the adult were discovered, it was thought that the specimens ascribed to *S. wrightii* were the young of *S. tuberculata*. I have no doubts now as to their distinctive nature, but it is evident that the two species are closely related.

472. **Spirillina tuberculata**, Brady (F 324) (Plate VIII, figs. 16, 17).

Three stations: 170, 175, 190.

Rare at St. 170; only a single large specimen at each of the other stations. This is the largest species of the genus, and so essentially Antarctic that it seems probable that the few records outside that area must refer to some other species.

Sub-family *ROTALIINAE*

Genus Patellina, Williamson, 1858

473. **Patellina corrugata**, Williamson (F 326) (SG 293).

Eight stations: 170, 175, 177, 363, 385, 386; WS 481, 482.

Rare or very rare everywhere, but very large specimens at Sts. 170 and WS 481. All the other stations yielded good but smaller specimens except Sts. 385 and 386, which are in very deep water, 3638–4773 m. At each of these a single example only was found, small and at St. 386 so pauperate as to be quite flat and scale-like.

Genus Discorbis, Lamarck, 1804

474. **Discorbis globularis** (d'Orbigny) (F 331) (SG 294).

Ten stations: 163, 164, 167, 175, 181, 195, 363, 366, 382; WS 482.

Common at St. WS 482 and frequent at St. 175, very rare elsewhere. Except for a single very small but typical specimen at St. 382 in 3647 m., all the records are from moderate depths, 18–395 m. Sessile specimens were found at Sts. 363 and WS 482.

475. **Discorbis globularis var. anglica**, Cushman (SG 295).

One station: 164.

A single specimen of this wild-growing variety.

476. **Discorbis vilardeboanus** (d'Orbigny) (F 333) (SG 297).

Nine stations: 164, 170, 175, 177, 180, 190, 201; WS 481, 482.

Common at St. 190, and frequent at Sts. 170, 175 and WS 482; elsewhere very rare.

477. **Discorbis peruvianus** (d'Orbigny) (F 335).

Three stations: 175, 177, 180.

Frequent at St. 175 in 200 m., very rare at the other stations.

478. **Discorbis rosaceus** (d'Orbigny) (F 334) (SG 298).

Seven stations: 195, 199, 363; Port Lockroy; WS 199, 389, 482.

Very rare everywhere and small.

479. **Discorbis turbo** (d'Orbigny) (F 339).

One station: 198.

A single good specimen from 1600 m. in the Bransfield Strait is the only record. But for the fact that the species occurs frequently in the Falkland area its occurrence would be open to suspicion as a "stray" from foul gear.

480. **Discorbis translucens**, sp.n. (Plate VIII, figs. 20–22).

One station: 385.

Test trochoid, plano-convex, the dorsal side a high cone with rounded apex, exhibiting about three convolutions with four chambers in the final convolution. Sutures flush and inconspicuous, peripheral edge acute and slightly lobulate. The ventral side flattened and rather concave, the umbilical portion showing weak asterigerine folds. Aperture normal, very inconspicuous. Test hyaline-white, translucent when wet, and very finely perforated.

Diameter 0·20 mm.; height 0·10 mm.

Three specimens of this pretty little form were found at St. 385 just on the convergence in the Drake Strait, depth 3638 m. It is unlike any species with which I am acquainted, but evidently allied to the group of *D. turbo*.

481. **Discorbis bertheloti** (d'Orbigny) (F 345).

Three stations: 170, 385, 387.

Rare at St. 170 in 342 m.; very rare and small at the other stations, 385 and 387, which are in the deep water of the Drake Strait, 3102–3638 m.

482. **Discorbis chasteri** (Heron-Allen and Earland) (F 352) (SG 299).

Two stations: 363; WS 482.

Extremely rare at both stations.

483. **Discorbis parisiensis** (d'Orbigny) (F 349).

Three stations: 164, 170, 177.

Rare at St. 170, single specimens at the other stations, all small.

Genus **Heronallenia**, Chapman and Parr, 1930

484. **Heronallenia wilsoni** (Heron-Allen and Earland) (SG 302) (Plate VIII, figs. 30–32).

Two stations: 170, 175.

Confined to these two stations, where it is rare. The specimens are very fine and typical.

485. **Heronallenia gemmata**, sp.n. (Plate VIII, figs. 26–29).

Two stations: 385, 386.

Test free, minute, compressed and slightly biconvex; consisting of about eight chambers in an open spiral, rapidly increasing in size, six of which are in the final convolution. Dorsal surface nearly flat, unpolished but not rough, decorated with a series of low circular bosses which follow the curve of the shell and increase in size with its growth. They have the superficial appearance of inflated chambers. A similar series of smaller bosses appears on the ventral side, which is slightly convex, and they are more conspicuous than those on the dorsal side, because the ventral side is smooth and polished. When a test is examined in fluid, it is seen that these bosses are not chambers but solid columns of shell substance extending right through the test. They are extensions of the septal wall between the chambers. The chambers themselves are curiously shaped; when the test is immersed in fluid, but with the chambers still filled with air, they appear to be crescentiform and recurved, with a long tongue-shaped process extending backwards from the concave centre of the crescent and passing under the outer curve of the preceding chamber. This cannot be traced after the balsam penetrates the chambers. The aperture is an arched opening on the ventral side, depressed and near the inner edge of the final chamber. The peripheral edge is very slightly produced into a narrow round-edged carina.

Length 0·20–0·23 mm.; breadth 0·17–0·20 mm.; thickness 0·04 mm.

This very interesting little species occurs at two stations in the deep water of the Drake Strait. Four specimens were found at St. 385 in 3638 m., two of which were subsequently lost by breakage under examination. Two were found at St. 386 in 4773 m. St. 386 is outside the Antarctic convergence line, and St. 385 near the line.

The species is closely allied to *H.* (*Discorbina*) *lingulata*, Burrows and Holland, 1896 (in J.P. and B. 1866, etc., MFC, 1896, p. 297, pl. vii, figs. 33 *a–c*). That species which is a well-known fossil of the Australian Miocene and is also found living in Australian seas, is, however, very much larger than *H. gemmata*, and its bosses are less strongly developed and confined to the dorsal surface, the ventral side being smooth.

Genus **Lamarckina**, Berthelin, 1881

486. **Lamarckina haliotidea** (Heron-Allen and Earland) (F 381) (Plate VIII, figs. 23–25).

One station: WS 204.

A single megalospheric specimen from St. WS 204 is referred with some hesitation to this species. A study of further specimens is required; it may prove to be a new species, being much flatter than the type.

Genus Cibicides, Montfort, 1808

487. **Cibicides refulgens**, Montfort (F 355) (SG 303).

Twenty-three stations: 170, 175, 177, 180–2, 186, 190, 195, 196, 363, 366, 369, 385; WS 388, 389, 474, 476, 481, 482, 488, 516, 517.

Very common at Sts. 190 and WS 482 and common at Sts. 170, 175, 180 and 181, all of which are under 350 m.; frequent at Sts. 177, 363, 366 and WS 481 which are between 322 and 1080 m.; rare or very rare at the remaining stations, some of which are in deep water. Sessile specimens are frequent at Sts. 177, 190 and WS 482, and at Sts. 180, 181 and WS 482 sessile specimens were seen in the encysted condition with extended pseudopodial tubes, as described and figured in the Terra Nova report (H.-A. and E. 1922, TN, p. 207, pl. vii, fig. 23). They were, however, of rare occurrence compared with their abundance in the Ross Sea.

488. **Cibicides refulgens var. corticata**, var.n. (Plate VIII, figs. 46–48).

One station: WS 505.

Three specimens, the largest nearly 2·0 mm. in diameter and found at St. WS 505 in the Bellingshausen Sea, 1500 m., are evidently a varietal form of *C. refulgens*, which was not recorded at this station. The specimens have apparently lived in the sessile condition and become detached. They are noteworthy on account of the thickening of the wall on the ventral side with a secondary deposit of shell matter which is not smooth but granular, giving an ornamented appearance to the test. One specimen has several supplementary chambers, and is suggestive of some of the Soldanian figures of *C. variabilis*.

489. **Cibicides lobatulus** (Walker and Jacob) (F 356) (SG 304) (Plate VIII, figs. 42–45).

Twenty-three stations: 170, 175, 177, 180–2, 186, 190, 195, 196, 203, 363, 366, 384–6; WS 204, 468, 469, 482, 486, 494A, 506.

This universally distributed species is rare or very rare except at a few shallow-water stations, 170, 181, 190 and WS 482, where it is common and well developed, and Sts. 175 and 177 where it is frequent. The records run down to 4773 m., and in many instances good and typical specimens were found at great depths. Sessile specimens, also encysted individuals, were noted at Sts. 177, 180, 384 and WS 482. At two deep-water stations in the Drake Strait, Sts. 385 and 386, some of the specimens are extremely pauperate, forming a thin and scale-like test, very like *Discorbis cora* (d'Orbigny). They would hardly be recognizable as *Cibicides lobatulus*, but for intermediate specimens found at the same stations.

490. **Cibicides variabilis** (d'Orbigny) (F 358).

Two stations: WS 474, 482.

Single specimens only.

491. **Cibicides dispars** (d'Orbigny) (F 357) (SG 305).

One station: 201.

Two small specimens at this station constitute the only record of the species. It may have been overlooked at other stations owing to its size.

492. **Cibicides wuellerstorfi** (Schwager) (F 361) (SG 306).

Ten stations: 383–7; WS 204, 403, 468, 469, 505.

Four of the stations are outside or on the Antarctic convergence line, and all are in deep water, 1500–4773 m. The species is frequent at Sts. 384, 385 and WS 469, rare or very rare elsewhere. Curiously enough the best and largest specimens were found in the Bellingshausen Sea at St. WS 505, 1500 m., in the high latitude of 70° 10′ 30″ S, where the species was rare.

493. **Cibicides aknerianus** (d'Orbigny) (F 362) (SG 307).

Eight stations: 180, 369, 384; WS 204, 403, 469, 474, 511.

Rare or very rare everywhere.

494. **Cibicides pseudoungerianus**, Cushman (F 363) (SG 308).

Twenty-one stations: 170, 190, 196, 198, 201, 202, 204, 206, 360, 363, 366, 385, 386; WS 399, 403, 469, 474, 480, 485, 486, 517.

Common at St. 363 in the South Sandwich Islands, and frequent at Sts. 170, 386, WS 403, and 474. Otherwise very rare and often represented by single shells. The records extend down to 4773 m.

495. **Cibicides grossepunctatus**, sp.n. (Plate VIII, figs. 39–41).

Twelve stations: 170, 177, 180–2, 187, 196, 363; WS 495, 505, 506, 507A.

Test large, thick-walled, very coarsely perforated, inequilaterally biconvex, the dorsal side being flatter than the ventral. Consisting of about three convolutions, with 8–10 chambers in the final convolution. All convolutions visible on the dorsal side, but generally more or less obscured owing to the deposition of secondary shell substance concealing the sutures. Only the chambers of the last convolution are visible on the ventral side. Sutures recurved, flush or in the case of the later chambers somewhat depressed; peripheral edge rounded; aperture a broad slit with recurved lip, extending from the middle of the inner edge of the apertural face over the periphery into the inner edge of the final chamber on the dorsal side. Glassy when young, becoming dull with growth, dead shells being white and opaque.

Diameter up to 1·0 mm. or even more; thickness about 0·45 mm.

This is a large and striking species, very noticeable owing to its coarse perforations which in contrast with the dark hyaline walls look like white dots and lines.

It is common at St. 363 in the South Sandwich Islands; thence the records run from St. 170 at Clarence Island, where it is frequent, to the South Shetlands, Bransfield Strait and Palmer Archipelago, becoming increasingly plentiful at Sts. 180, 181 and 182. All of the foregoing stations are in comparatively shallow water, 160–500 m., but it is also common at St. 177 in 1080 m. Outside this favoured area the records are few and usually confined to single specimens, the water being deeper and ranging down to 2582 m. at St. WS 495.

Sessile and also encysted specimens were observed at St. 182.

Genus **Rupertia**, Wallich, 1877

496. **Rupertia stabilis**, Wallich (Plate X, figs. 23–25).

Rupertia stabilis, Wallich, 1877, R, p. 502, pl. xx, figs. 1–12, ? 13.
Rupertia stabilis, Brady, 1884, FC, p. 680, pl. xcviii, figs. 1–12.
Rupertia stabilis, Cushman, 1918, etc., FAO, 1931, p. 138, pl. xxv, figs. 3–9.

One station: WS 505.

A few excellent specimens from 1500 m. at St. WS 505, which is in the extreme south of the Bellingshausen Sea, near the ice barrier (70° 10′ 30″ S, 87° 46′ W). This is a very noteworthy extension of the range of a species which, though particularly of North Atlantic and Arctic habitat, has been recorded occasionally from all parts of the world. But it was not found by the Scotia, Terra Nova, or Gauss expeditions in the Antarctic, and so far as I know its extreme southern record hitherto has been at Challenger St. 317, to the north of the Falkland Islands in 48° 37′ S, 55° 17′ W, 1035 fathoms.

Genus **Globorotalia**, Cushman, 1927

497. **Globorotalia hirsuta** (d'Orbigny) (F 374) (SG 315).

Five stations: WS 204, 403, 468, 469, 471.

Common at Sts. WS 403 and 469 and frequent at St. WS 204, rare elsewhere. All the specimens are very thick-walled. The depths range from 3328 to 4344 m., and two of the stations are outside or just within the Antarctic convergence line.

498. **Globorotalia scitula** (Brady) (F 375) (SG 316).

Six stations: 180, 385, 387; WS 204, 469, 474.

Common at St. 387 and frequent at St. 385, elsewhere rare or very rare. The specimens are all of a large thick-walled benthic type, except the single specimen found at St. 180 in 160 m. which is small and thin shelled. All the other stations are in deep water, 2813–3959 m.

499. **Globorotalia menardii** (d'Orbigny) (F 378).

One station: WS 393.

A single small and thick-walled specimen.

500. **Globorotalia crassa** (d'Orbigny) (F 376) (SG 317).

Eight stations: 180, 200, 201, 387; WS 393, 469, 471, 474.

Frequent at St. WS 469, elsewhere rare or very rare. Except at Sts. 387 and WS 469 the specimens are all small.

501. **Globorotalia truncatulinoides** (d'Orbigny) (F 377) (SG 318).

Thirteen stations: 384–7; WS 204, 205, 403, 468, 469, 472, 474, 517, 555.

Confined to deep water in the Scotia and Bellingshausen Seas, 2770–4773 m., several of the stations being outside the Antarctic convergence line. It is common or very common at Sts. 385, 386, 387, WS 204, 205, 403, 468 and 469, and frequent at St. 384; rare elsewhere. The thick-shelled low form figured in the South Georgia report (pl. iv, figs. 35–7) is the usual representative of the species, but at Sts. 387 and WS 468 a complete series connecting that with the normal thin-walled type was seen. Of two specimens found at St. WS 517 one was the thick-walled form and the other specimen was thin-walled, perhaps pelagic. At St. 385 an abnormal specimen with a young individual permanently attached to its test was found. It is similar in nature to the abnormal *Globigerinae* described on p. 175.

Genus Eponides, Montfort, 1808

502. **Eponides umbonatus** (Reuss) (F 386) (SG 322).

Ten stations: 383, 384, 385, 386; WS 204, 205, 403, 468, 469, 505.

Common at Sts. 384, 385 and WS 403, and frequent at St. WS 204; rare or very rare elsewhere. The thick-walled typical *Rotalina umbonata* only was found at Sts. 383, 384 and WS 403, the thin-walled *Truncatulina tenera* (see F 386) only at Sts. WS 469 and 505. At the remaining stations both forms were observed and transition stages could be found. The stations are all in the deep water of the Scotia Sea, Drake Strait and Bellingshausen Sea, ranging between 1500 m. at St. WS 505 which is in the far south of the Bellingshausen Sea, near the ice barrier, to 4773 m. at St. 386 in the Drake Strait outside the Antarctic convergence line.

503. **Eponides karsteni** (Reuss) (F 391) (SG 324).

Six stations: 167, 180; WS 468, 469, 474, 483.

Very rare everywhere. The stations are confined to the Scotia Sea, South Orkneys and South Shetlands, the southern limit being at St. 180 in the Palmer Archipelago, where the single specimen found was very small.

504. **Eponides exiguus** (Brady) (F 387) (SG 323).

Thirty-three stations: 175, 180, 190, 195, 203, 209, 363, 366, 384–7; 62° 57′ S, 60° 20′ 30″ W; WS 204, 205, 389, 392, 393, 395, 403, 468, 469, 476, 482, 486, 488, 495, 498, 503, 505, 506, 507B, 516.

Widely distributed, but reaching its maximum in size and frequency in two distinct areas, the deep water of the Scotia Sea and Drake Strait, and in the Bellingshausen Sea. It is very common at St. WS 403 and common at St. 385; frequent at Sts. 384, 386, WS 204 and 205, all of which are deep-water stations in the first area. It is also common at Sts. WS 505, 506 in the second or Bellingshausen Sea area, where the specimens attain an unusual size for the species. The depths at these two stations are less, 1500–584 m. At most of the remaining stations, many of which are in quite shallow water, the species is rare and the specimens small.

505. **Eponides tumidulus** (Brady) (F 366) (SG 312).

Twenty-four stations: 177, 363, 384–6; WS 204, 205, 393, 395, 399, 403, 468, 472, 482, 495, 498, 503, 505, 506, 507A, 507B, 511, 513, 517.

Common at Sts. 384, 385, WS 403, 506, 507A and 507B and frequent at Sts. 386 and WS 204; elsewhere very rare. The depths range between 100 and 4773 m., but the majority are in deep or very deep water, and at the shallow-water stations the specimens are often far from typical. There is even greater range in the height of the shell than is illustrated in Brady's figures. The most generally distributed and common form is low-domed. At Sts. WS 505, 506, 507A and 507B a variety occurs in some numbers, but less common than the usual type at those stations. It is characterized by the sudden increase in size of the chambers of the last convolution, which accounts for more than half of the total width of the shell.

506. **Eponides bradyi**, sp.n. (F 367) (SG 313) (Plate VIII, figs. 36–38).

Truncatulina pygmaea, Brady (*non* Hantken), 1884, FC, p. 666, pl. xcv, figs. 9, 10.

Ten stations: 383–7; WS 204, 205, 403, 468, 469.

Frequent to common at all stations except St. 387, where it is very rare. All the stations are in the deep water of the Drake Strait and Scotia Sea, and on both sides of the convergence line.

The organism figured by Brady under the name *Truncatulina pygmaea*, Hantken, is not Hantken's fossil species; the latter has a sunken umbilicus, whereas the recent form has a solid convex umbilical stud. In other respects the two forms are very similar.

Cushman (C. 1927, FWCA, p. 165, pl. v, figs. 11–13) has selected one of Brady's figures (fig. 10, *ut supra*) as a type of his species *Pulvinulinella bradyana*, but the attribution is apparently based on the resemblance of the dorsal face of his species to Brady's figure. Brady's type is in the British Museum (Natural History) and I have examined it. The specimen from which fig. 10 was drawn is easily identified, but it is a sealed mount and neither the specimen nor the figure exhibit the aperture, which is the vital point in the separation of *Eponides* from *Pulvinulinella*. An examination of many specimens from Challenger St. 5 (24° 20′ N, 24° 28′ W, 2740 fathoms) proves that Brady's fig. 10 illustrates a young individual of the same species as his fig. 9, and that both young and old specimens have the typical aperture of *Eponides* on the inner edge of the terminal face, and not the reverted loop parallel to the peripheral edge which characterizes *Pulvinulinella*. *P. bradyana*, Cushman, is therefore unrelated to the organism figured by Brady, which I have renamed *Eponides bradyi*. The records in the Falklands (F 367) and South Georgia reports (SG 313) should be amended from *Truncatulina bradyana* to *Eponides bradyi*. Cushman's specific name holds good for the organism he described from the West coast of America.

The description of the species is: Test thick-walled, biconvex, the convexity increasing with age; dorsal side with three or more convolutions, but usually only the last convolution can be traced owing to secondary deposits of shell substance; 7–9 chambers in final convolution, sutures oblique, flush and generally indistinct; ventral side showing only the chambers of the final convolution, and more distinctly than on the dorsal side; sutures flush and recurved; umbilical area filled with a solid stud of shell substance; aperture an arched slit on the inner edge of the face of the final chamber, variable in size.

Diameter of Discovery specimens up to 0·45 mm.; thickness 0·25 mm. It attains larger proportions elsewhere.

Eponides bradyi is essentially a deep-water species, and found in all the oceans, but appears to be more frequent in the Pacific than elsewhere.

507. **Eponides sidebottomi**, sp.n. (Plate VIII, figs. 33–35).

Two stations: WS 205, 403.

Test small, hyaline, biconvex, dorsal side exhibiting 2–3 convolutions with five chambers in the final convolution. Sutures flush and nearly straight. Peripheral edge rounded. Ventral side exhibiting only the five chambers of the final convolution; sutures oblique, slightly recurved. Umbilicus solid and flush. Aperture a small curved slit on the inner edge of the apertural face.

Breadth 0·23 mm.; thickness 0·15 mm.

Four specimens at St. WS 403 and one at St. WS 205, depths 3721–4207 m. The most interesting feature about this otherwise rather obscure little form was the presence on one of the specimens of a large inflated "balloon" or accessory chamber, nearly as large as the organism itself, identical with that figured by Sidebottom (S. 1918, FECA, p. 261, pl. vi, figs. 27–29) on an organism which he ascribed to *Rotalia soldanii*, with hesitation. The balloon in my specimen was so extremely thin and fragile that it collapsed in mounting.

Sidebottom's organism was certainly not *Rotalia soldanii* but an *Eponides*. It is not the same as the Discovery form, having nine chambers to the convolution, but in other respects is very similar. The purport of the "balloon" chamber in two different organisms is obscure. It may be compared with the similar structure found occasionally in *Polymorphina williamsoni* Terquem, and figured in the Falklands report (F 285, pl. xii, fig. 28). I have named the Discovery species after the first observer of the "balloon".

Genus **Epistomina**, Terquem, 1883

508. **Epistomina elegans** (d'Orbigny) (F 385) (SG 321).

Two stations: WS 469, 505.

One very small specimen was found at St. WS 469 in the Scotia Sea (3959 m.), and two large specimens at St. WS 505 in the far south of the Bellingshausen Sea (1500 m.). The latter were dead and worn shells of the thick-walled *partschiana* type. This position, 70° 10′ 30″ S, 87° 46′ W, is in a very high latitude for the species, though it was recorded by the Terra Nova from 69° 51′ S, 166° 17′ W.

Genus **Laticarinina**, Galloway and Wissler, 1927

509. **Laticarinina pauperata** (Parker and Jones) (SG 326).

One station: WS 204.

Only two small specimens from a depth of 3328 m.

Genus **Rotalia**, Lamarck, 1804

510. **Rotalia beccarii** (Linné) (F 393) (SG 327).

Two stations: 180; WS 482.

A single small specimen at each station. They are very like the specimens figured by Brady (B. 1884, FC, pl. cvii, fig. 5) and ascribed by him to *R. orbicularis*, which they certainly are not, but young or pauperate *R. beccarii* (see H.-A. and E. 1922, TN, p. 219, No. 599). Brady figures *R. orbicularis* correctly on a subsequent plate, pl. cxv, fig. 6.

511. **Rotalia orbicularis** (d'Orbigny).

Gyroidina orbicularis, d'Orbigny, 1826, TMC, p. 278, no. 1; Modèle no. 13.
Rotalia orbicularis, Brady, 1884, FC, p. 706, pl. cxv, fig. 6.
Gyroidina orbicularis, Cushman, 1918, etc., FAO, 1931, p. 37, pl. viii, figs. 1, 2.

Six stations: 385; WS 469, 505, 506, 507A, 507B.

Frequent but small at St. 385 in 3688 m., and a single larger specimen at St. WS 469, 3959 m. Elsewhere rare except at St. WS 505 where it is frequent. The specimens here and at the other Bellingshausen Sea stations, WS 506, 507A, 507B, are generally small and far from typical.

512. **Rotalia soldanii**, d'Orbigny (F 394A) (SG 328).

Eleven stations: 369, 384–6; WS 204, 205, 403, 468, 469, 493, 507B.

Frequent at several deep-water stations in the Scotia Sea and Drake Strait, Sts. 386, WS 204 and 469; rare elsewhere. Particularly large specimens were found at Sts. 385 and WS 469, but the general average is rather small; the species is very small and pauperate at Sts. WS 493 and 507B.

Family NUMMULINIDAE

Sub-family *NONIONINAE*

Genus **Nonion**, Montfort, 1808

513. **Nonion depressulus** (Walker and Jacob) (F 399) (SG 329).

Forty-four stations: 170, 175, 177, 180, 181, 186, 192, 194–6, 198, 202–4, 363, 377, 382, 386; 64° 56′ S, 64° 43′ W; WS 382–5, 391, 394–6, 476, 480–2, 484–6, 488, 493, 494A, 495, 497, 506, 507A, 512–14.

Generally distributed and occurring at all depths down to 4773 m., but the only stations at which it is common or frequent are under 1000 m., and it reaches its optimum development under 300 m. At greater depths it is very rare, often represented by a single specimen. The best stations are 181, WS 395, 476, 482 and 488.

514. **Nonion umbilicatulus** (Walker and Jacob) (F 401) (SG 332).

Thirty-eight stations: 170, 171, 175, 177, 180, 181, 186, 187, 190, 194–6, 200, 202, 206, 363, 369; 64° 56′ S, 64° 43′ W; WS 204, 383, 385, 386, 393–5, 476, 480, 482, 485–8, 493, 494A, 498, 505, 507B, 513.

Never very common, but frequent at Sts. 180, WS 395 and 486, all of which are in moderate depths, also at St. WS 204 in 3328 m. There is great variation in the extent of the umbilical depression, the best specimens being from the deep stations, where the species passes almost imperceptibly into *N. pompilioides*.

515. **Nonion pompilioides** (Fichtel and Moll) (F 402) (SG 333).

Nine stations: 383–6; WS 205, 403, 468, 469, 472.

Frequent at Sts. 384, 385, 386, WS 468 and 469; very rare at the other stations. All of them are over 3500 m.

516. **Nonion stelliger** (d'Orbigny) (F 404) (SG 335).

Twenty stations: 170, 175, 177, 180–2, 190, 196, 200, 363, 366; WS 377, 471, 481, 482, 486, 490, 493, 494A, 506.

Frequent at St. 190, rare or very rare elsewhere, often only a single specimen. The most typical examples were found at St. 175 in 200 m., but generally speaking the local form is large and very compressed, the compression reaching its maximum at St. 177 in 1080 m., where some of the specimens were almost scale-like. Most of the records are in moderate depths, but they extend down to 3762 m. at St. WS 471, where the single specimen was entirely chitinous.

517. **Nonion boueanus** (d'Orbigny) (F 405) (SG 336).

One station: 385.

A single small specimen.

518. **Nonion sloanii** (d'Orbigny) (F 403) (SG 334).

Two stations: WS 481, 482.

One very good specimen at St. WS 481, and a few small ones at St. WS 482. This, like *N. grateloupi*, is normally a warm-water species.

519. **Nonion grateloupi** (d'Orbigny) (F 406) (SG 337).

One station: 201.

A single excellent specimen from 343 m. in the Bransfield Strait. This is generally regarded as a warm-water species, and its occurrence so far south is noteworthy.

520. **Nonion scapha** (Fichtel and Moll) (F 407) (SG 338).

Ten stations: 194; WS 383, 395, 476, 482, 487, 496, 506, 507A, 507B.

Rare or very rare everywhere, and the specimens are small and pauperate. The weak variety named by Chapman *N. scapha* var. *bradii* (B. 1884, FC, pl. cix, fig. 16; C. 1914, FORS, p. 71, pl. v, fig. 42) was observed at several stations but was not separated.

521. **Nonion pauperatus** (Balkwill and Wright) (F 408).

Two stations: WS 395, 486.

One very small specimen at St. WS 395 in 297 m., and another, exceptionally large, at St. WS 486 in 787 m. Both stations are in the Bransfield Strait.

Genus **Nonionella**, Cushman, 1926

522. **Nonionella iridea**, Heron-Allen and Earland (F 410) (SG 339).

Thirty-five stations: 162, 167, 180, 190, 194–6, 202, 203, 360, 362, 366, 369, 385; WS 383–5, 387, 391, 393, 395, 403, 476, 481–3, 485–7, 496, 497, 507B, 509, 511, 512.

Common at Sts. WS 481, 482 and 487 and frequent at Sts. 162, 196, 203, WS 383, 485 and 486, but rare or very rare at other stations. The depths extend from shallow water down to 3721 m., but very few specimens were observed at the deeper stations, except at WS 383 (2085 m.).

523. **Nonionella turgida** (Williamson) (SG 340).

Seventeen stations: 170, 177, 190, 195, 196, 203, 369, 384; WS 383, 385, 476, 479, 481, 483, 485, 487, 510.

Frequent at St. WS 487, rare or very rare elsewhere.

Genus **Elphidium**, Montfort, 1808

524. **Elphidium incertum** (Williamson) (F 412) (SG 341).

Four stations: 177, 180, 187; WS 498.

Common and typical at St. 187 in the Palmer Archipelago, 200 m.; very rare elsewhere.

525. **Elphidium excavatum** (Terquem) (F 413).

One station: 385.

A single small and pauperate specimen from deep water (3638 m.) in the Drake Strait, just within the Antarctic convergence line.

526. **Elphidium magellanicum**, Heron-Allen and Earland (F 416).

One station: 363.

A single typical specimen from 329 m. in the South Sandwich Islands.

527. **Elphidium macellum** (Fichtel and Moll) (F 418).

One station: 175.

Only a single specimen.

528. **Elphidium owenianum** (d'Orbigny) (F 419) (SG 345).

Five stations: 170, 194; WS 480, 482, 494B.

Extremely rare; single small specimens, except at St. 170 where two were found. The depths range between 50 and 812 m. and the stations are in the line between the South Orkneys and the Bransfield Strait.

Sub-family *NUMMULITINAE*

Genus **Operculina**, d'Orbigny, 1826

529. **Operculina balthica** (Schroeter).

Nautilus balthicus, Schroeter, ECK, 1783–6, vol. i, p. 20, pl. i, fig. 2.
Nonionina elegans, Williamson (*non* d'Orbigny), 1858, RFGB, p. 35, pl. iii, figs. 74, 75.
Operculina ammonoides, Carpenter, Parker and Jones (*non* Gronovius), 1862, IF, p. 310.
Operculina ammonoides, Brady (*non* Gronovius), 1884, FC, p. 745, pl. cxii, figs. 1, 2.
Operculina ammonoides, Heron-Allen and Earland (*non* Gronovius), 1913, CI, p. 147; 1922, TN, p. 230.
Anomalina balthica, Cushman, 1918, etc., FAO, 1931, p. 108, pl. xix, fig. 3.
Anomalina balthica, Hofker, 1932, GNA, p. 136, figs. in text 44, 45.

One station: 180.

This little species is a true cosmopolitan, and often very abundant in cold water, though Cushman says it is not found in the Western Atlantic. It was found by the Terra Nova in the far south of the Ross Sea, but Pearcey does not record it in the Weddell Sea, or Wiesner from Kaiser Wilhelm's Land. It occurs at St. 180 only, in the Palmer Archipelago, 160 m., where it is very rare.

As the synonyms indicate the species has been placed in several genera. Cushman now transfers it to *Anomalina*, and Hofker follows suit. The chief objections to its figuring as an *Operculina* have been its small size, cold-water habitat, and the apparent absence of the canal system which is so highly developed in the tropical species of that genus. But Hofker has recently demonstrated the existence of a simple canal system, which seems fatal to its continuance in the genus *Anomalina*.

SUPPLEMENTARY BIBLIOGRAPHY

See Part I, pp. 443–51; Part II, p. 133.

The following are the titles of papers other than those referred to in Parts I, II of this report.

B. 1880, FAM. M. Berthelin. *Mémoire sur les Foraminifères Fossiles de l'Étage Albien de Montcley (Doubs).* Mém. Soc. Géol. France, sér. 3, i, 1880, No. 5, pp. 1–78, pls. xxiv–vii (i–iv).

B. P. and J. 1870, P. H. B. Brady, W. K. Parker and T. R. Jones. *A Monograph of the Genus* Polymorphina. Trans. Linn. Soc. Lond., xxvii, 1870, pp. 197–253, pls. xxxix–xlii, and text-figs.

C. 1870, ODSD. W. B. Carpenter. *Descriptive Catalogue of Objects from Deep-sea Dredgings, exhibited at the Soirée of the Royal Microscopical Society, King's College, April 20th, 1870.* London, 1870, pp. 1–11.

C. 1881, M. W. B. Carpenter. *The Microscope and its Revelations.* Sixth edition, pp. 882, pls. i–xxv, text-figs. 1–502. London, 1881.

C. 1891, etc., GF. F. Chapman. *The Foraminifera of the Gault of Folkestone.* JRMS., 1891, pp. 565–75; 1892, 319–30, 749–58; 1893, 579–95; 1894, 154–63, 421–7, 645–54; 1896, 1–14, 581–91; 1898, 1–49.

C. 1924, FSA. F. Chapman. *A First Report on Foraminifera collected by the South African Government Fisheries and Marine Biological Survey.* Union of South Africa. Fisheries and Marine Biological Survey. Report No. 3. For the year 1922. Issued June 1924. No. xi, pp. 1–19, pl. i.

C. 1909, A. J. A. Cushman. Ammodiscoides, *a New Genus of Arenaceous Foraminifera.* Proc. U.S. Nat. Mus., xxxvi, pp. 423–4, pl. xxxiii.

C. 1928, etc., F. J. A. Cushman. *Foraminifera, their Classification and Economic Use.* Sharon, Mass., U.S.A. First edition, 1928, pp. 1–401, pls. i–lix and text-figs. Second edition, August, 1933, pp. 1–349, pls. i–xxxi and text-figs. Supplementing the second edition is a separate volume. See C. 1933, IKGF.

C. 1932, etc., TPA. J. A. Cushman. *The Foraminifera of the Tropical Pacific Collections of the 'Albatross',* 1899–1900. U.S. Nat. Mus. Bull. 161. Part 1. 1932. Astrorhizidae to Trochamminidae, pp. i–vi, 1–88, pls. i–xvii; Part 2. 1933. Lagenidae to Alveolinellidae, pp. i–vi, 1–79, pls i–xix. (*In course of publication*; figures and descriptions of some new species from Part 3 are published in C. 1925, etc., LFR, 1933, No. 137.)

C. 1933, IKGF. J. A. Cushman. *An Illustrated Key to the Genera of the Foraminifera.* Sharon, Mass., U.S.A. August, 1933. 26 pp., pls. i–xl.

C. 1933, NAF. J. A. Cushman. *New Arctic Foraminifera collected by Capt. R. A. Bartlett from Fox Basin and off the North-east Coast of Greenland.* Publication 3221. Smithsonian Misc. Coll., 1933, lxxxix, No. 9, pp. 1–8, pls. i–ii.

C. and V. 1930, SWF. J. A. Cushman and W. W. Valentine. *Shallow-water Foraminifera from the Channel Islands of Southern California.* Cont. Dept. Geol. Stanford University, 1930, i, No. 1, pp. 1–51, pls. i–x.

E. 1933, SG. A. Earland. *Foraminifera. Part II. South Georgia.* Discovery Reports, vii, pp. 27–138, pls. i–vii.

F. 1883, FPS. C. Fornasini. *Nota preliminare sui Foraminiferi della marna Pliocenica del Ponticello di Savena nel Bolognese.* Boll. Soc. Geol. Ital., ii, fasc. 2, 1883, pp. 176–90, pl. ii.

F. 1886, LF. C. Fornasini. *Varietà di* Lagena *Fossile negli strati a* Pecten hystrix *del Bolognese.* Boll. Soc. Geol. Ital., v, 1886, pp. 350–3, pl. viii.

F. 1896, TC. C. Fornasini. *Di alcune forme Plioceniche della* Textilaria candeiana *e della* T. concava. Mem. R. Accad. Sci. Istit. Bologna, ser. v, vi, 1896, pp. 1–6 (reprints 3–8), pl. O.

G. and M. 1929, LTE. J. J. Galloway and Margaret Morrey. *A Lower Tertiary Foraminiferal Fauna from Manta, Ecuador.* Bull. Amer. Palaeont., 1929, xv, No. 55, pp. 7–56, pls. i–vi.

G. and W. 1927, PFLQ. J. J. Galloway and Stanley G. Wissler. *Pleistocene Foraminifera from the Lomita Quarry, Palos Verdes Hills, California.* Journ. Palaeontology, i, No. 1, 1927, pp. 35–87, pls. vii–xii.

H.-A. and E. 1932, F. E. Heron-Allen and A. Earland. *Foraminifera. Part i. The Ice-Free Area of the Falkland Islands and Adjacent Seas.* Discovery Reports, iv, pp. 291–460, pls. vi–xvii.

H. 1932, GNA. J. Hofker. *Notizen ueber die Foraminiferen des Golfes von Neapel.* III. *Die Foraminiferenfauna der Ammontatura.* Pubbl. Stazione Zool. Napoli, 1932, xii, fasc. 1, pp. 61–144, text-figs. 1–45.

J. 1872, RFL. F. W. O. Rymer Jones. *On some Recent Forms of* Lagenae *from Deep-sea Soundings in the Java Seas.* Trans. Linn. Soc. Lond., xxx, 1872, pp. 45–69, pl. xix.

K. 1870, KL. F. Karrer. *Ueber ein neues Vorkommen von oberer Kreideformation in Leitzersdorf bei Stockerau und deren Foraminiferenfauna.* Jahrb. K.K. geol. Reichsanst., Vienna, 1870, xx, pp. 157–84 (pls. x–xi). (*Note.* The plates are numbered x–xi but the explanations of the plates are numbered i–ii and references in text are to pls. i–ii.)

K. 1877, KFJW. F. Karrer. *Geologie der Kaiser Franz-Josefs Hochquellen-Wasserleitung. Eine Studie in den Tertiär-Bildungen am Westrande des alpinen Theiles der Niederung von Wien.* Abhandl. K.K. geol. Reichsanst., ix, 1877, pp. 1–420, 20 plates.

L. 1930, LPCM. E. Lacroix. *Les Lituolidés du plateau continental méditerranéen entre Saint-Raphaël et Monaco.* Bull. de l'Inst. Océanog., Monaco, 1930, No. 549, pp. 1–16, text-figs. 1–21.

M. 1931, MES. W. A. Macfadyen. *Miocene Foraminifera from the Clysmic Area of Egypt and Sinai. With an Account of the Stratigraphy and a Correlation of the Local Miocene Succession.* Geological Survey of Egypt, Government Press, Cairo, May, 1931 (1930 on title page), pp. 1–149, pls. i–iv, 2 maps.

M. 1933, FFBB. W. A. Macfadyen. *Fossil Foraminifera from the Burdwood Bank and their Geological Significance.* Discovery Reports, Cambridge, 1933, vii, pp. 1–16, 2 text-figs.

M. 1876, PRC. John Murray. *Preliminary Reports to Professor Wyville Thomson, F.R.S., Director of the Civilian Scientific Staff, on Work done on board the 'Challenger'.* Proc. Roy. Soc. Lond., 1876, xxiv, pp. 471–544, pls. xx–xxiv.

M. 1933, MTF. Earl H. Myers. *Multiple Tests in the Foraminifera.* Proc. Nat. Acad. Sci., 1933, xix, No. 10, pp. 893–9, pl. i, 2 figs. in text.

N. 1889. M. Neumayr. *Die Stämme des Thierreiches.—Wirbellose Thiere.* Vol. i, ch. ii, *Protozoen*, pp. 156–210, text-figs. 14–34. Vienna and Prague, 1889.

d'O. 1849, etc., PP. A. D. D'Orbigny. *Prodrome de Paléontologie stratigraphique universelle des Animaux mollusques et rayonnés—faisant suite au cours élémentaire de Paléontologie et de Géologie stratigraphiques.* 3 vols. Paris, i, 1849; ii, 1850; iii, 1852.

P. 1888, FFC. F. G. Pearcey. *Notes on the Foraminifera of the Faroe Channel and Wyville Thomson Ridge, with a Description of a New Species of* Hyperammina. Trans. Nat. Hist. Soc. Glasgow, ii (N.S.), 1888, pp. 163–79, pl. iii.

R. 1845–6, VBK. A. E. Reuss. *Die Versteinerungen der böhmischen Kreideformation.* Stuttgart. Part i, 1845, Part ii, 1846.

R. 1855, TD. A. E. Reuss. *Beiträge zur Charakteristik der Tertiärschichten des nördlichen und mittleren Deutschlands.* Sitz. K. Ak. Wiss. Wien, 1855, xviii (2), pp. 197–273, pls. i–xii.

R. 1860, FWK. A. E. Reuss. *Die Foraminiferen der westphälischen Kreideformation.* Sitz. K. Ak. Wiss. Wien, xl, 1860, pp. 147–238, pls. i–xiii.

R. 1862–3, FFL. A. E. Reuss. *Die Foraminiferen-Familie der Lagenideen.* Sitz. K. Ak. Wiss. Wien, xlvi, Abth. i, 1862 (1863), pp. 303–42, pls. i–vii.

R. 1867, FSW. A. E. Reuss. *Die fossile Fauna der Steinsalzablagerungen von Wieliczka.* Sitz. K. Ak. Wiss. Wien, 1867, lv, Abth. i, pp. 17–182, pl. i–viii.

R. 1885, NMO. A. Rzehak. *Die Foraminiferenfauna der Neogenformation der Umgebung von Mähr-Ostrau.* Verh. Nat. Ver. Brünn, xxiv, i, 1885 (1886), pp. 77–123, 1 pl.

S. 1783–6, ECK. J. S. Schroeter. *Einleitung in die Conchylien-Kenntniss nach Linné.* 3 vols. Halle, 1783–6.

S. 1910, TNC. H. Sidebottom. *Two New Species of* Cassidulina. Journ. Quekett Microsc. Club, ser. 2, ii, pp. 105–8, pl. iv.

T. 1932, NCE. Hans E. Thalmann. *Nomenclator (Um- und Neubenennungen) zu den Tafeln 1 bis 115 in H. B. Brady's Werk über die Foraminiferen der Challenger-Expedition, London, 1884.* Eclogae geologicae Helvetiae, 1932, xxv, No. 2, pp. 293–312.

V. 1933, BROF. T. Wayland Vaughan. *The Biogeographic Relations of the Orbitoid Foraminifera.* Proc. Nat. Acad. Sci., 1933, xix, No. 10, pp. 922–38.

W. 1877, R. G. C. Wallich. *On* Rupertia stabilis, *a new Sessile Foraminifer from the North Atlantic.* Ann. Mag. Nat. Hist., 1877, ser. 4, xix, pp. 501–4, pl. xx.

W. 1934, FRS. A. S. Warthin, Jnr. *Foraminifera from the Ross Sea.* American Museum Novitates, No. 721, May 4, 1934, pp. 1–4, text-figs. 1–5.

W. 1885–6, BLP. J. Wright. *Foraminifera of the Belfast Naturalists' Field Club's Cruise off Belfast Lough, in the Steam-tug 'Protector', June,* 1885*; also Foraminifera found by Dr Malcomson, at Rockport, Belfast Lough.* Proc. Belfast Naturalists Field Club, Appendix, 1885–6, pp. 317–26, pl. xxvi.

W. 1902, FRI. J. Wright. *Some Foraminifera from Rathlin Island.* Irish Naturalist, Sept. 1902, xi, No. 9, pp. 211–13, pl. iii.

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PLATE I

Figs. 1, 2. *Miliolina insignis*, Brady (No. 25). × 14. Fig. 1, back view. Fig. 2, oral-end view showing abnormal aperture. For front view see Pl. IX, fig. 1.

Figs. 3, 4. *Spiroloculina pusilla*, sp.n. (No. 11). × 45. Fig. 3, side view. Fig. 4, oral-end view.

Figs. 5–7. *Miliolina labiosa* (d'Orbigny) (No. 26). × 45. Fig. 5, side view. Fig. 6, edge-oral view. Fig. 7, oral-end view.

Figs. 8, 9. *Ophthalmidium margaritiferum*, Heron-Allen and Earland (No. 44). × 45. Fig. 8, side view. Fig. 9, oral-edge view.

Fig. 10. *Bathysiphon argillaceus*, sp.n. (No. 75). × 20. Showing contorted mass of pseudopodia at apertural end.

Fig. 11. *Dendronina arborescens* var. *antarctica*, Heron-Allen and Earland (No. 65). × 25. A fragment attached to zoophyte.

Fig. 12. *Pelosphaera cornuta*, Heron-Allen and Earland (No. 49). × 25. Part of a spirit-preserved specimen showing the flexible Astrorhizid filaments of mud and protoplasm emerging from the conical processes. See also Pl. IX, figs. 3–4.

Figs. 13, 14. *Astrorhiza polygona*, sp.n. (No. 48). × 25. Fig. 13, normal specimen. Fig. 14, abnormal specimen with accessory aperture.

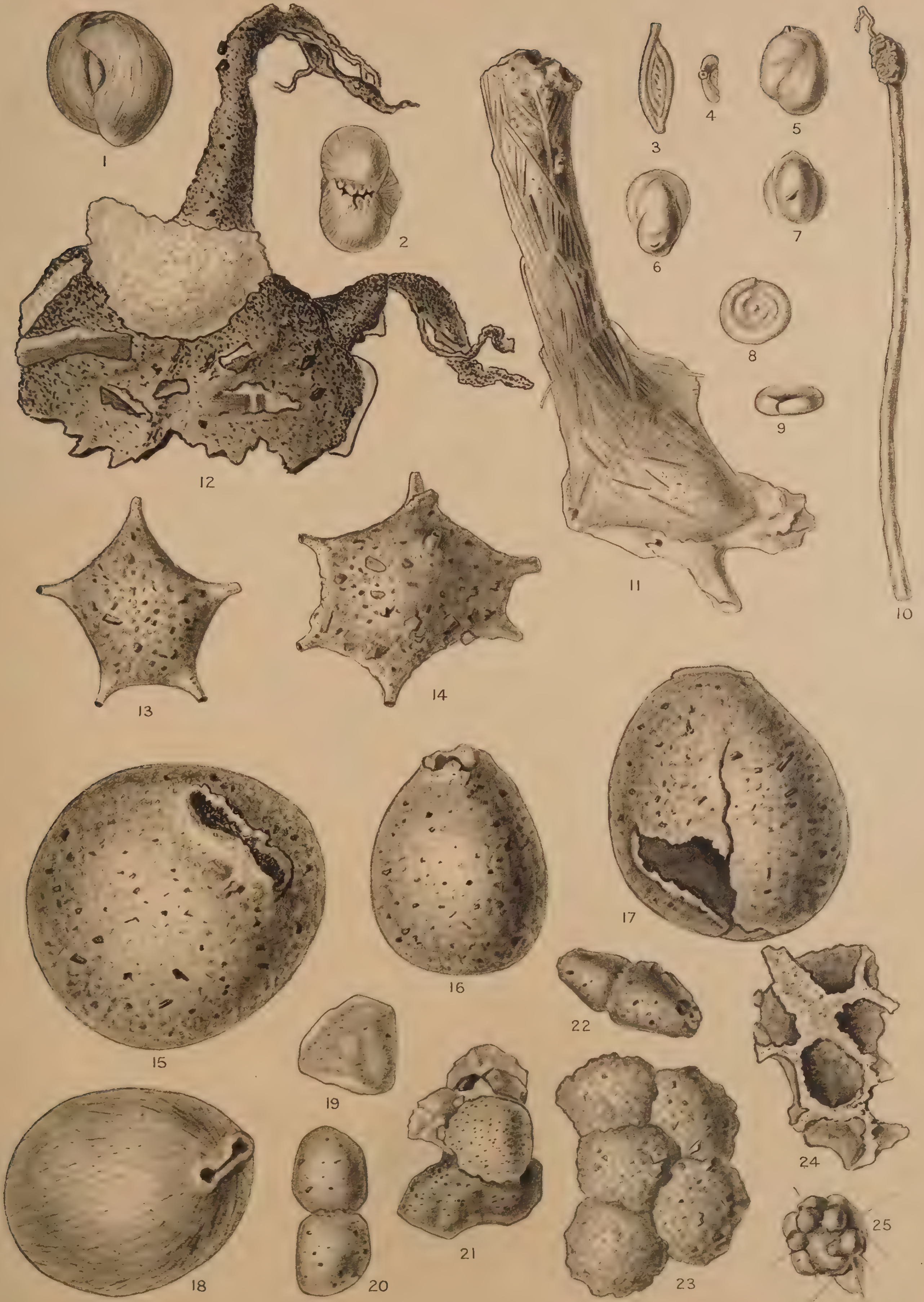
Figs. 15–17. *Pilulina arenacea*, sp.n. (No. 69). × 25. Fig. 15, normal specimen showing aperture. Fig. 16, young oval specimen. Fig. 17, a broken test to show the thickness of the wall.

Fig. 18. *Pilulina jeffreysii*, Carpenter (No. 68). × 25. A young oval specimen. See also Pl. IX, figs. 11–13.

Figs. 19–21. *Sorosphaera depressa*, Heron-Allen and Earland (No. 77). × 25. Fig. 19, a single chamber which has become detached from a quadrate colony. Fig. 20, a two-chambered free growing specimen. Fig. 21, a single chambered specimen sessile on sand grains.

Figs. 22–24. *Sorosphaera socialis*, sp.n. (No. 78). × 25. Fig. 22, a young colony of two chambers. Fig. 23, a colony with five chambers. Fig. 24, fragment of a large colony with outer wall denuded.

Fig. 25. *Sorosphaera confusa*, Brady (No. 76). × 25. A free colony of many chambers with investing spicules.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ANTARCTIC FORAMINIFERA

PLATE II

Fig. 1. *Sorosphaera socialis*, sp.n. (No. 78). × 25. A large colony of many individual chambers, some of which are broken.

Figs. 2–5. *Psammophax consociata*, Rhumbler (No. 82). × 25. Fig. 2, an association of two chambers. Figs. 3–4, of three chambers. Fig. 5, of many chambers and incorporating sponge spicules.

Fig. 6. *Urnula quadrupla*, Wiesner (No. 89). × 45. A young individual and an association of four chambers, sessile on a pebble.

Figs. 7–9. *Technitella bradyi*, sp.n. (No. 88). × 25. Various aspects.

Fig. 10. *Tholosina laevis*, Rhumbler (No. 95). × 25. A specimen sessile on *Reophax pilulifer*, Brady.

Fig. 11. *Thurammina murata*, Heron-Allen and Earland (No. 107). × 45.

Figs. 12–14. *Armorella sphaerica*, Heron-Allen and Earland (No. 98). × 25. Specimens with unusually long tubes.

Figs. 15–18. *Thurammina corrugata*, sp.n. (No. 103). × 25. Illustrating the extreme range of form.

Figs. 19, 20. ? *Jaculella acuta*, Brady (No. 110). Fig. 19, × 25. A young individual with chitinous primordial chamber. Fig. 20, × 70. Another young individual with two chitinous chambers.

Fig. 21. *Hyperammina tubulosa*, sp.n. (No. 120). × 25.

Fig. 22. *Hospitella manumissa*, Rhumbler (No. 131). × 45. A specimen with many chambers sessile on a sand grain.

Figs. 23–26. *Botellina goësii*, sp.n. (No. 132). × 25. Fig. 23, labyrinthine interior visible in broken end view.

Fig. 27. *Reophax bicameratus*, sp.n. (No. 146). × 25.

Fig. 28. *Reophax catenulatus*, Cushman (No. 149). × 25. Fragment with two chambers.

Figs. 29, 30. *Reophax communis*, Lacroix (No. 139). × 45.

Fig. 31. *Reophax guttifer*, Brady (No. 147). × 45.

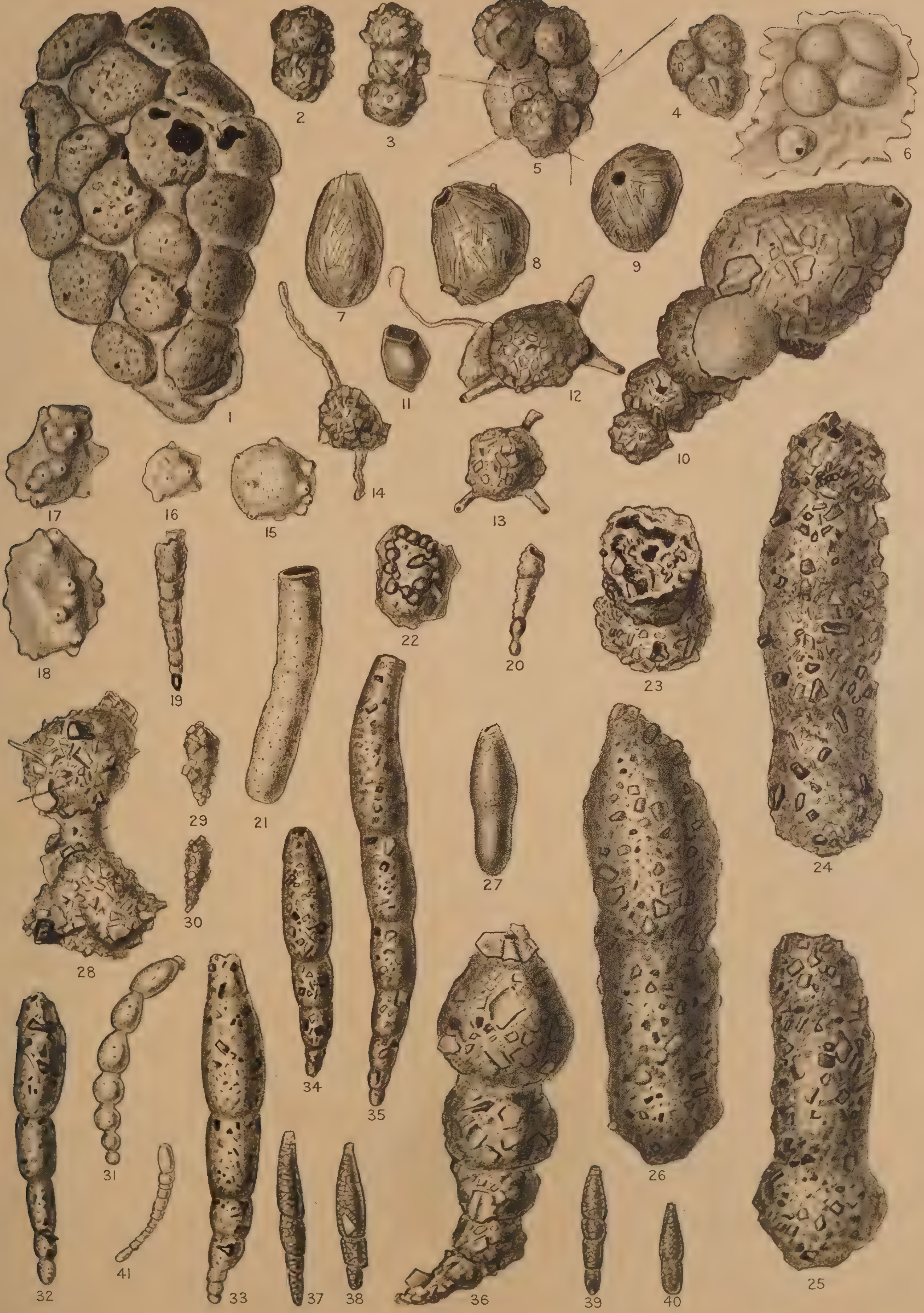
Figs. 32–35. *Reophax dentaliniformis*, Brady (No. 140). × 45. Fig. 32, typical. Figs. 33, 35, Antarctic form. Fig. 34, intermediate variety.

Fig. 36. *Reophax pilulifer*, Brady (No. 137). × 13. Microspheric form. See Pl. II, fig. 10 for the megalospheric form.

Figs. 37–40. *Reophax micaceus*, sp.n. (No. 143). × 45.

Fig. 41. *Nodellum membranaceum* (Brady) (No. 153). × 45.

PLATE II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ANTARCTIC FORAMINIFERA

PLATE III

Fig. 1. *Hormosina ovicula*, Brady (No. 155). × 12.

Fig. 2. *Hormosina ovicula* var. *gracilis* (Earland) (No. 156). Drawn to the same magnification as Fig. 1, to illustrate the difference in sizes.

Figs. 3–6. *Haplophragmoides nitidus* (Goës) (No. 165). Fig. 3, edge-oral view. Figs. 4–6, side views, illustrating differences of texture. Figs. 3, 4 × 35; 5, 6 × 60.

Figs. 7, 8. *Haplophragmoides quadratus*, sp.n. (No. 164). × 70. Fig. 7, side view. Fig. 8, edge-oral view.

Fig. 9. *Haplophragmoides trullissatus* (Brady) (No. 162). × 75. Abnormal.

Fig. 10. *Haplophragmoides canariensis* (d'Orbigny) (No. 158). × 28. A number of young individuals attached to some foreign body.

Figs. 11–13. *Ammobaculites agglutinans* var. *filiformis*, var.n. (No. 171). × 70. Illustrating variations in construction. Fig. 11, normal construction. Fig. 12, using cement almost entirely. Fig. 13, coarse construction.

Figs. 14–17. *Ammobaculites foliaceus* var. *recurva*, var.n. (No. 175). × 70. Fig. 14, dorsal and Fig. 15, ventral side views of young individuals. Fig. 16, dorsal view of adult. Fig. 17, dorsal-edge view of adult.

Fig. 18. *Placopsilinella aurantiaca*, gen. et sp.n. (No. 178). × 70. Sessile on a fragment of *Cassidulina* with a *Globigerina* attached to it.

Fig. 19. *Ammodiscoides turbinatus*, Cushman (No. 182). × 80. A young individual viewed as a transparent object.

Figs. 20–23. *Ammoflintina trihedra*, gen. et sp.n. (No. 187). × 70. Fig. 20, viewed as a transparent object; the last chamber is broken. Fig. 21, opaque, last chamber broken. Figs. 22–23, opaque, side views.

Figs. 24–27. *Trochammina alternans*, sp.n. (No. 201). × 60. Figs. 24–26, dorsal views. Fig. 27, ventral view.

Figs. 28–31. *Trochammina discorbis*, sp.n. (No. 204). × 100. Figs. 28–29, dorsal views. Fig. 30, ventral view. Fig. 31, edge view.

Figs. 32–34. *Trochammina globulosa*, Cushman (No. 198). × 45. Fig. 32, edge view. Fig. 33, dorsal view. Fig. 34, ventral view.

Figs. 35–37. *Trochammina grisea*, sp.n. (No. 194). × 45. Fig. 35, dorsal view. Fig. 36, ventral view. Fig. 37, edge-oral view.

Figs. 38–40. *Trochammina inconspicua*, sp.n. (No. 199). × 100. Figs. 38, 40, dorsal views. Fig. 39, edge-oral view.

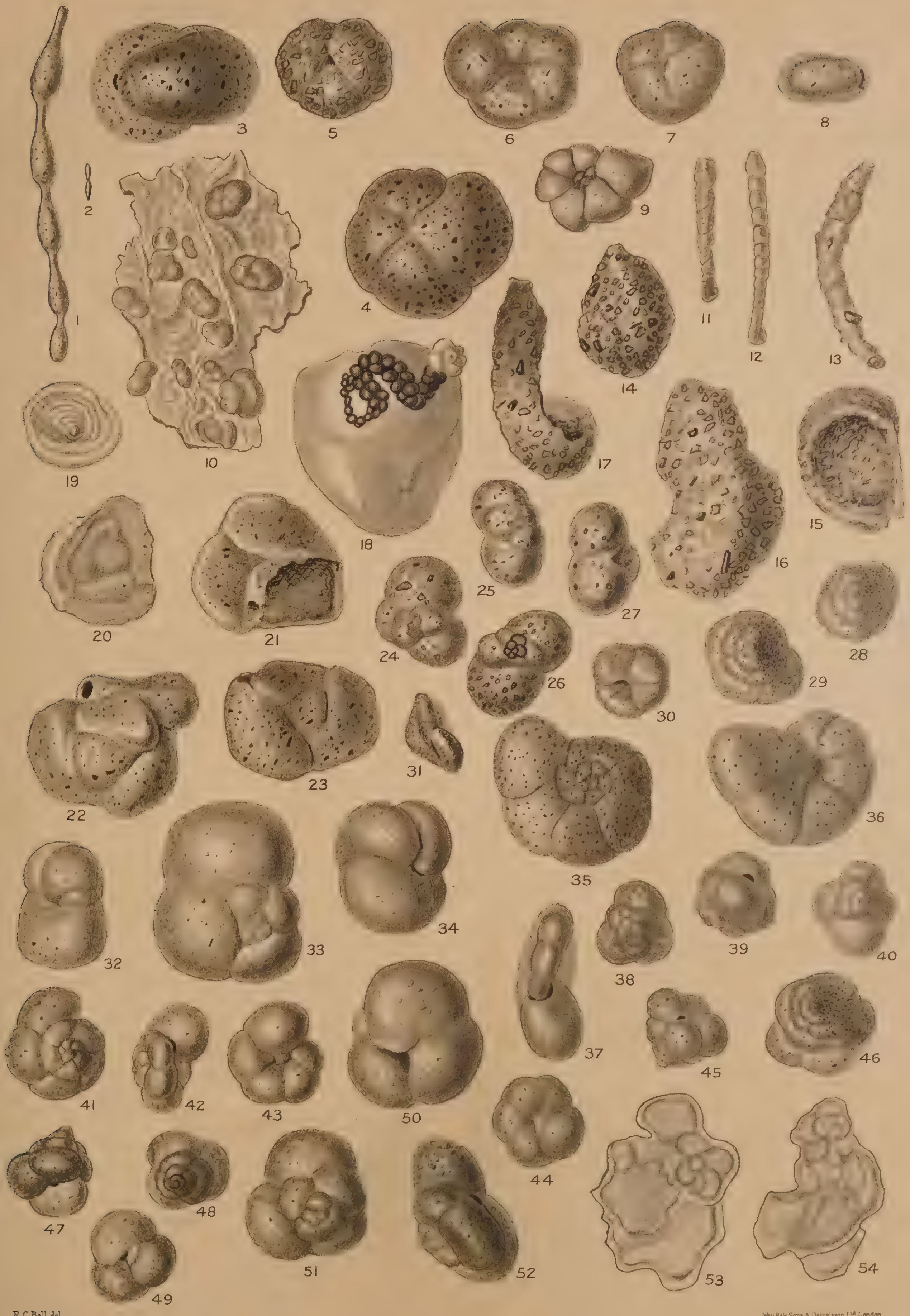
Figs. 41–43. *Trochammina inflata* (Montagu) (No. 191). × 70. Fig. 41, dorsal view. Fig. 42, edge-oral view. Fig. 43, ventral view.

Figs. 44–46. *Trochammina vesicularis*, Goës (No. 202). × 80. Fig. 44, ventral view. Fig. 45, edge-oral view. Fig. 46, dorsal view.

Figs. 47–49. *Trochammina conica*, sp.n. (No. 203). × 75. Fig. 47, edge-oral view. Fig. 48, dorsal view. Fig. 49, ventral view.

Figs. 50–52. *Trochammina tricamerata*, sp.n. (No. 200). × 70. Fig. 50, ventral view. Fig. 51, dorsal view. Fig. 52, edge-oral view.

Figs. 53, 54. *Ammocibicides proteus*, gen. et sp.n. (No. 209). × 70. Specimens mounted in balsam. They show the initial spiral and the thickened margin.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ANTARCTIC FORAMINIFERA

PLATE IV

Figs. 1–7. *Ammocibicides proteus*, gen. et sp.n. (No. 209). Figs. 1, 2, 4 × 75; 3, 5–7 × 45. To illustrate the variable forms. Fig. 1 is regularly spiral. Figs. 2, 3, spiral assuming biserial arrangement. Figs. 4–6, spiral becoming entirely irregular. Fig. 7, spiral aborted.

Figs. 8–12. *Ammocibicides pontoni*, sp.n. (No. 210). × 75. Figs. 8, 9, dorsal views of spiral form. Fig. 10, edge view of same. Fig. 11, spiral assuming uniserial arrangement, dorsal view. Fig. 12, edge-oral view of same.

Figs. 13–16. *Spirolocammina tenuis*, gen. et sp.n. (No. 215). × 75. Fig. 13, side view as a transparent object. Figs. 14, 15, side views, opaque. Fig. 16, edge view.

Figs. 17–19. *Cystammina argentea*, sp.n. (No. 207). × 75. Fig. 17, side view of a specimen viewed as a transparent object. Fig. 18, side view, as an opaque object. Fig. 19, top view.

Figs. 20–24. *Miliammina arenacea* (Chapman) (No. 216). × 45. Fig. 20, front view of coarsely arenaceous type from South Sandwich Islands. Fig. 21, oral end view, normal type. Fig. 22, front view. Fig. 23, back view. Fig. 24, edge-oral view, all normal type.

Figs. 25–29. *Miliammina circularis*, Heron-Allen and Earland (No. 220). × 45. Fig. 25, back view. Fig. 26, front view. Fig. 27, oral-end view. Fig. 28, edge view. Fig. 29, section.

Figs. 30–32. *Spiroplectammina filiformis*, sp.n. (No. 224). × 70. Fig. 30, side view. Fig. 31, edge view (back). Fig. 32, side view as a transparent object.

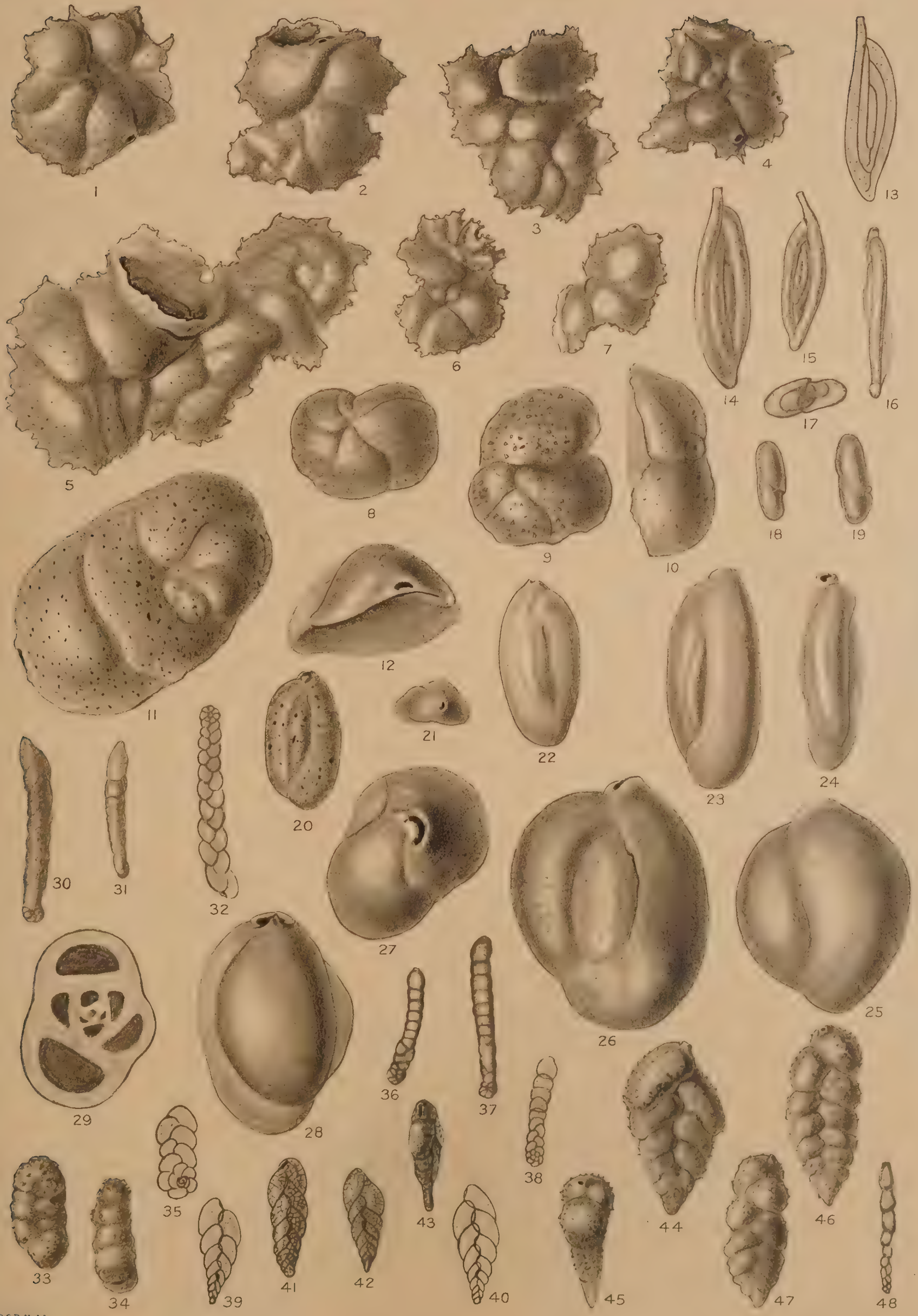
Figs. 33–35. *Spiroplectammina subcylindrica*, sp.n. (No. 223). × 80. Fig. 33, side view. Fig. 34, edge view (front). Fig. 35, side view as a transparent object.

Figs. 36–38. *Spiroplectella cylindroides*, gen. et sp.n. (No. 225). × 70. Figs. 36, 37, side views, opaque. Fig. 38, side view as a transparent object.

Figs. 39–43. *Textularia antarctica* (Wiesner) (No. 232). × 75. Fig. 39, microspheric specimen, side view, transparent. Fig. 40, the same, megalospheric. Fig. 41, side view, opaque megalospheric. Fig. 42, the same, microspheric. Fig. 43, edge-oral view.

Figs. 44–47. *Textularia catenata*, Cushman (No. 228). × 70. Fig. 44, side view, normal. Figs. 45, 46, side views, the later chambers showing a bigenerine tendency. Fig. 45, edge-oral view.

Fig. 48. *Bigenerina minutissima*, Earland (No. 233). × 65.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ANTARCTIC FORAMINIFERA

PLATE V

Figs. 1–8. *Delosina sutilis*, sp.n. (No. 265). × 45. Fig. 1, side view, microspheric. Figs. 2, 6, side views, megalospheric. Figs. 5, 7, edge views, megalospheric. *Note*. The oral end is at the base of these figures. Fig. 3, apical or aboral view, megalospheric. Fig. 4, oral view. Fig. 8, a horizontal section showing five chambers (oral end at top). The earliest chamber has a loop shaped aperture; no communication between the subsequent chambers. On the right the sutural extension covering a canal is broken away; the situation of the canal can be seen in the corresponding position on the left side. The oral tubes are seen in section at the top.

Figs. 9–15. *Delosina wiesneri*, sp.n. (No. 266). × 45. Figs. 9–11 are drawn from paratypes obtained by the 'Gauss' expedition. Fig. 9, side and base view of a microspheric specimen. Fig. 10, basal or oral view, megalospheric. Fig. 11, interior view of a detached final chamber. The wide inner ring is the surface of attachment to the previous chamber. Wiesner's canal is the dark line running round the upper half. The side canals ("stitches") are the short dark lines which run off from it to the sutural edge. Figs. 14, 15, upper views. Fig. 12, under view. Fig. 13, edge view. All megalospheric. Figs. 12–15 are drawn from Discovery specimens.

Fig. 16. *Delosina complexa* (Sidebottom) (No. 262). × 70. Oral end at top, side view.

Figs. 17, 18. *Verneuilina bradyi*, Cushman (No. 234). × 75. Side views.

Figs. 19–21. *Verneuilina bradyi* var. *nitens*, Wiesner (No. 235). × 80. Fig. 19, side view. Fig. 20, top view. Fig. 21, base view.

Figs. 22–26. *Verneuilina minuta*, Wiesner (No. 240). × 75. Fig. 22, top view. Figs. 23, 24, side views, microspheric. Fig. 26, side view, megalospheric. Fig. 25, side view microspheric, viewed as a transparent object.

Figs. 27–29. *Textularia paupercula*, sp.n. (No. 227). × 70. Fig. 27, side view as a transparent object. Fig. 28, the same, opaque. Fig. 29, edge-oral view.

Figs. 30–34. *Verneuilina superba*, sp.n. (No. 238). × 45. Figs. 30–33, side views in different stages of growth and position. Fig. 34, side view as a transparent object.

Figs. 35, 36. *Gaudryina apicularis*, Cushman (No. 243). × 75. Fig. 35, side view. Fig. 36, edge-oral view.

Figs. 37–40. *Gaudryina deformis*, sp.n. (No. 242). × 45. Figs. 37, 39, young specimens. Fig. 38, adult, side-oral view. Fig. 40, adult, side-aboral view.

Figs. 41–44. *Gaudryina ferruginea*, Heron-Allen and Earland (No. 245). × 75. Figs. 41, 42, young individuals in the triserial stage. Fig. 43, adult, side view. Fig. 44, adult, edge-oral view.

Figs. 45, 46. *Gaudryina minuta*, sp.n. (No. 244). × 110. Fig. 45, side view as a transparent object. Fig. 46, the same, opaque.

Figs. 47–49. *Gaudryina pauperata*, sp.n. (No. 246). × 100. Fig. 47, side view. Fig. 48, edge view. Fig. 49, side view, as a transparent object.

Figs. 50, 51. *Robertina minutissima* (J. Wright) (No. 253). × 85. Fig. 50, back view. Fig. 51, front-oral view.

Figs. 52, 53. *Robertina arctica*, d'Orbigny (No. 252). × 78. Fig. 52, back view. Fig. 53, front-oral view.

Figs. 54, 55. *Virgulina schreibersiana*, Czyzek var. *complanata*, Egger (No. 270). × 75. Fig. 54, back view. Fig. 55, front-oral view.

PLATE V

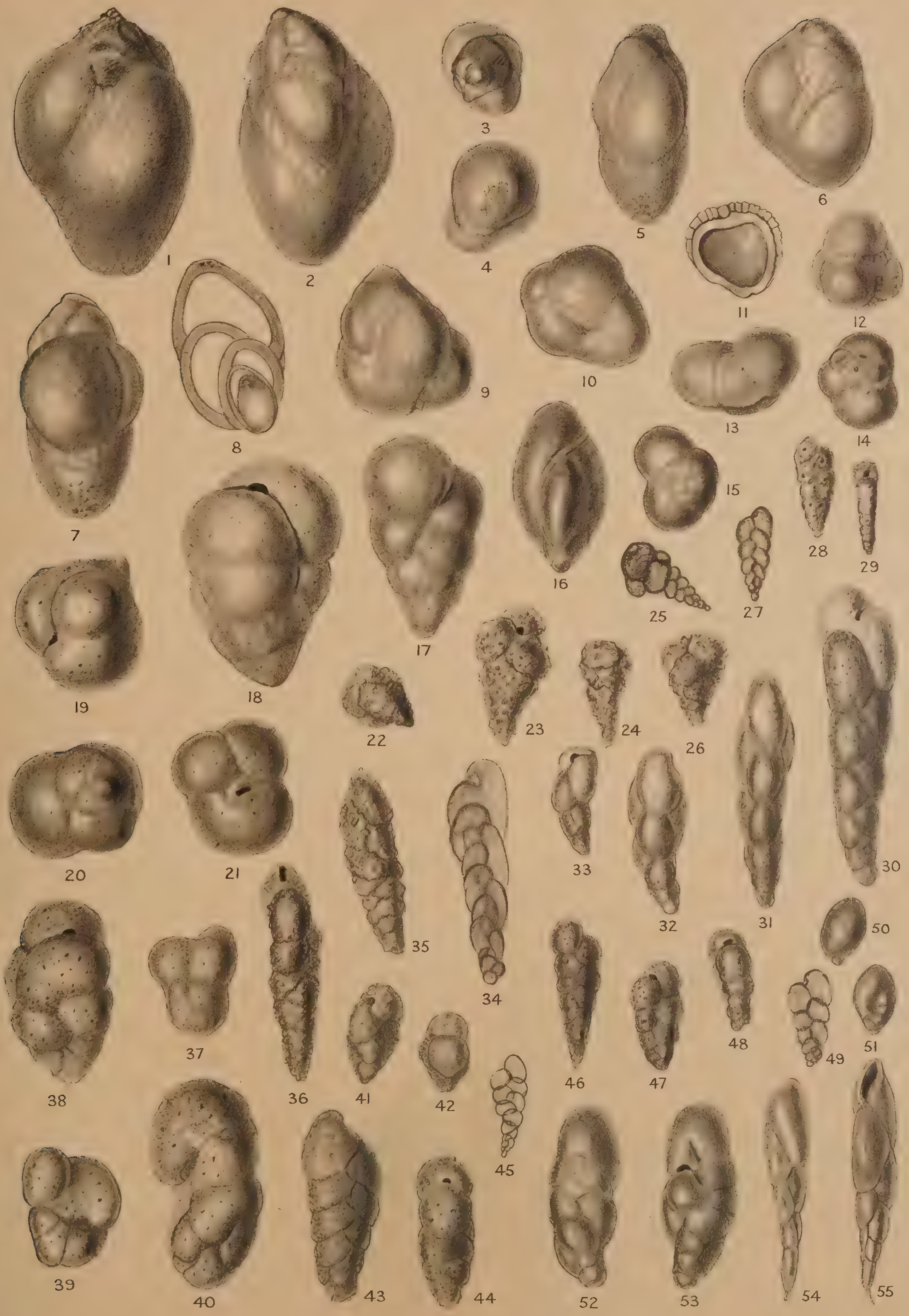
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PLATE VI

Figs. 1–4. *Virgulina subdepressa*, Brady (No. 271). × 40. Fig. 1, megalospheric, side view. Fig. 2, the same, edge-oral view. Fig. 3, microspheric, side view. Fig. 4, the same, edge-oral view.

Figs. 5–7. *Bolivina punctata*, d'Orbigny (No. 272). × 70. Side views. Fig. 5, microspheric. Fig. 6, megalospheric Fig. 7, ? pauperate form.

Figs. 8–10. *Bolivina spinescens*, Cushman (No. 274). × 70. Figs. 8–9, side views. Fig. 10, edge-oral view.

Figs. 11–14. *Pseudobulimina chapmani* (Heron-Allen and Earland) (No. 282). × 40. Figs. 11, 14, edge views. Fig. 12, ventral view. Fig. 13, dorsal view. Fig. 14 is drawn from a transparent specimen, external lines in black, *part* of the internal structure in tone.

Figs. 15, 16. *Cassidulina elegans*, Sidebottom (No. 290). × 70. Fig. 15, oral view. Fig. 16, dorsal view.

Figs. 17–20. *Cassidulina lens*, sp.n. (No. 285). × 40. Figs. 17, 18, 20, side views. Fig. 17, as a transparent object. Figs. 18, 20, opaque. Fig. 19, edge view.

Figs. 21, 22. *Cassidulina subglobosa*, Brady (No. 288). × 40. Abnormal specimens.

Figs. 23–25. *Cassidulina pacifica*, Cushman (No. 291). × 40. Fig. 23, front oral view. Fig. 24, edge view. Fig. 25, dorsal view.

Figs. 26, 27. *Cassidulina subglobosa* var. *tuberculata*, Heron-Allen and Earland (No. 289). × 40. Fig. 26, front oral view. Fig. 27, edge view.

Figs. 28–32. *Ehrenbergina parva*, sp.n. (No. 298). × 75. Fig. 28, ventral view, opaque, megalospheric. Fig. 29, edge view, the same. Fig. 31, end-oral view, the same. Fig. 32, as Fig. 28 viewed as a transparent object. Fig. 31, edge view, opaque, microspheric.

Figs. 33–35. *Ehrenbergina hystrix*, Brady (No. 295). × 40. Fig. 33, dorsal view. Fig. 34, oral end view. Fig. 35, ventral view.

Fig. 36. *Lagena apiculata* (Reuss) (No. 308). × 70. Cylindrical variety.

Figs. 37, 38. *Lagena aspera*, Reuss (No. 309). × 70. Fig. 37, side view. Fig. 38, oral end view.

Figs. 39, 40. *Lagena basireticulata*, sp.n. (No. 313). × 80. Fig. 39, side view. Fig. 40, base view.

Figs. 41, 42. *Lagena clowesiana*, sp.n. (No. 323). × 70. Fig. 41, edge view. Fig. 42, side view.

Fig. 43. *Lagena torquata*, Brady (No. 408). × 70.

Figs. 44, 45. *Lagena desmophora*, Rymer Jones (No. 328). × 70. Fig. 44, pauperate form comparable with Rymer Jones's original figure No. 23. Fig. 45, strongly costate form as figured by Brady and other authors.

Figs. 46, 47. *Lagena fimbriata*, Brady (No. 333). × 75. Spinous forms.

Figs. 48, 49. *Lagena deaconi*, sp.n. (No. 327). × 75. Fig. 48, side view. Fig. 49, edge view.

Figs. 50, 51. *Lagena glans*, sp.n. (No. 339). Fig. 50, side view. × 40. Fig. 51, a fragment showing detail of ornament. × 150.

Fig. 52. *Lagena globosa* (Montagu) var. *setosa*, var.n. (No. 342). × 50.

Figs. 53, 54. *Lagena guntheri*, sp.n. (No. 346). × 75. Fig. 53, oral end view. Fig. 54, side view.

Figs. 55–57. *Lagena heronalleni*, sp.n. (No. 348). Figs. 55, 57, side views. × 50. Fig. 56, detail of rib structure showing the quadrangular pits with enclosing shell layer. × 150.

Figs. 58–60. *Lagena hispidula*, Cushman (No. 351). × 70. Showing range of form. Fig. 59 shows rupture of outer layer and inner supporting spines.

Figs. 61–63. *Lagena johni*, sp.n. (No. 353). × 75. Fig. 61, partial side view. Fig. 62, basal and side view. These two figures show the basal auricles. Fig. 63, edge view.

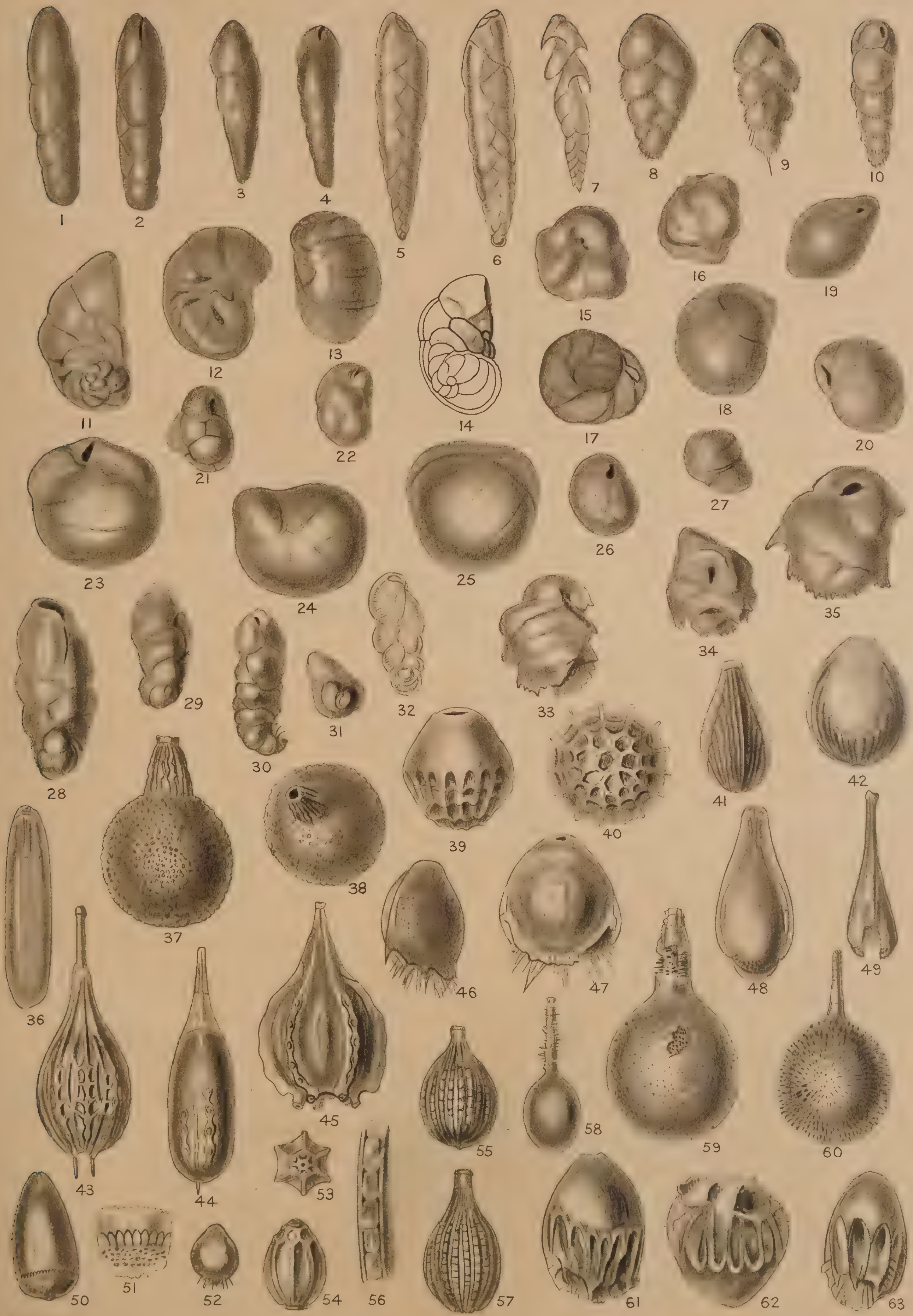
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PLATE VII

Fig. 1. *Lagena lagenoides* (Williamson) var. *debilis*, var. n. (No. 357). × 45. Trigonal.

Fig. 2. *Lagena marginata* (Walker and Boys) var. *cushmani*, Wiesner (No. 365). × 40.

Figs. 3, 4. *Lagena marginata* var. *spinifera*, var.n. (No. 370). × 70. Fig. 4, edge view.

Figs. 5, 6. *Lagena palliolata*, sp.n. (No. 377). × 75. Fig. 5, edge view.

Figs. 7, 8. *Lagena pseudauriculata*, sp.n. (No. 379). × 75. Fig. 7, edge view.

Fig. 9. *Lagena quadrilatera*, sp.n. var. *striatula*, var.n. (No. 382). × 75.

Figs. 10, 11. *Lagena quadrilatera*, sp.n. (No. 381). × 70. Fig. 11, end-oral view under greater magnification.

Figs. 12, 13. *Lagena reniformis*, Sidebottom var. (No. 384). × 75. Fig. 13, edge-oral view.

Figs. 14, 15. *Lagena scottii*, Heron-Allen and Earland (No. 387). × 45. Fig. 14, side view showing erosion of outer layer. Fig. 15, oral end view.

Figs. 16–18. *Lagena seguenziana*, Fornasini (No. 388). × 75. Fig. 16, side view. Fig. 17, edge view. Fig. 18, oral end view.

Figs. 19, 20. *Lagena semilineata*, J. Wright (No. 389). × 70.

Fig. 21. *Lagena semilineata* var. *spinigera*, var.n. (No. 390). × 70.

Fig. 22. *Lagena seminuda*, Brady (No. 391). × 50.

Fig. 23. *Lagena sidebottomi*, nom.n. (No. 393). × 80.

Figs. 24, 25. *Lagena squamoso-alata*, Brady (No. 395). × 75. Fig. 25, edge view.

Figs. 26–28. *Lagena squamoso-sulcata*, Heron-Allen and Earland (No. 396). × 70. Fig. 26, abnormal double shell. Fig. 27, basal-side view.

Figs. 29, 30. *Lagena striata* (d'Orbigny) var. (No. 402). × 80.

Figs. 31–35. *Lagena texta*, Wiesner (No. 407). × 75. Fig. 31, side view. Fig. 32, oral side view. Fig. 33, edge view. Fig. 34, abnormal two-sided specimen. Fig. 35, abnormal four-sided specimen.

Figs. 36, 37. *Lagena ventricosa*, A. Silvestri, var. (No. 409). × 75. Abnormal form with basal carina. Fig. 37, oral end view.

Figs. 38, 39. *Lagena virgulata*, Sidebottom (No. 411). × 75. Fig. 38, edge view.

Figs. 40, 41. *Nodosaria communis*, d'Orbigny var. *larva*, var.n. (No. 416). × 45. Fig. 40, megalospheric. Fig. 41, microspheric.

Figs. 42, 43. *Nodosaria raphanistrum* (Linné) var. (No. 421). × 75. Pauperate.

Figs. 44, 45. *Cristellaria compressa*, d'Orbigny (No. 430). × 45. Fig. 44, side view. Fig. 45, front edge view.

Figs. 46, 47. *Cristellaria obtusata*, Reuss (No. 427). × 40. Fig. 46, front edge view. Fig. 47, side view.

Figs. 48, 49. *Cristellaria saulcyi*, d'Orbigny (No. 429). × 26. Fig. 49, front-edge view.

Figs. 50, 51. *Lagena globosa* (Montagu) var. *tenuissimestriata*. Schubert (No. 343). × 45. Fig. 51, basal view.

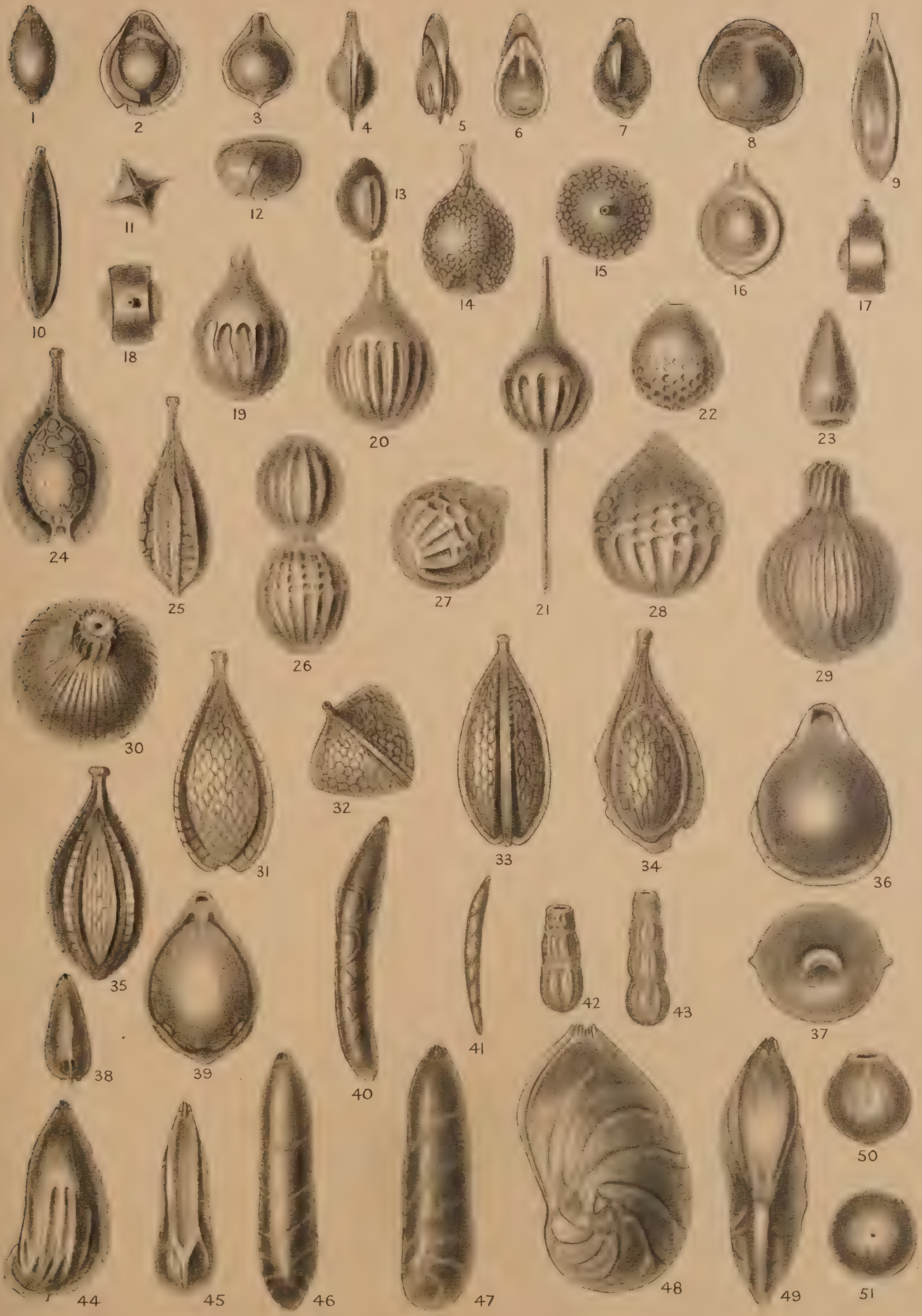
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PLATE VIII

Figs. 1, 2. *Cristellaria subarcuatula* (Montagu) (No. 428). × 26. Fig. 2, front edge view.

Figs. 3, 4. *Polymorphina angusta*, Egger (No. 445). × 70.

Fig. 5. *Polymorphina extensa*, Cushman (No. 448). × 70.

Figs. 6–8. *Polymorphina scoresbyana*, sp.n. (No. 449). × 40.

Figs. 9–12. *Globigerina megastoma*, sp.n. (No. 463). × 43.

Figs. 13–15. *Globigerina triloba*, Reuss, spinous variety (No. 458). × 40.

Figs. 16, 17. *Spirillina tuberculata*, Brady (No. 472). × 28. Fig. 16, under surface. Fig. 17, upper surface.

Figs. 18, 19. *Spirillina wrightii*, Heron-Allen and Earland (No. 471). × 40. Fig. 18, upper surface. Fig. 19, under surface.

Figs. 20–22. *Discorbis translucens*, sp.n. (No. 480). × 75. Fig. 20, edge view. Fig. 21, ventral view. Fig. 22, dorsal view.

Figs. 23–25. ? *Lamarckina haliotidea* (Heron-Allen and Earland) (No. 486). × 75. Fig. 23, dorsal view. Fig. 24, ventral view. Fig. 25, edge view.

Figs. 26–29. *Heronallenia gemmata*, sp.n. (No. 485). × 75. Figs. 26, 27, opaque. Fig. 26, dorsal view. Fig. 27, ventral view. Figs. 28, 29, as transparent objects. Fig. 28, dorsal, Fig. 29, ventral.

Figs. 30–32. *Heronallenia wilsoni* (Heron-Allen and Earland) (No. 484). × 80. Fig. 30, dorsal view. Fig. 31, ventral view. Fig. 32, edge view.

Figs. 33–35. *Eponides sidebottomi*, sp.n. (No. 507). × 75. Fig. 33, edge view. Fig. 34, ventral view. Fig. 35, dorsal view of specimen with terminal balloon chamber.

Figs. 36–38. *Eponides bradyi*, sp.n. (No. 506). × 45. Fig. 36, dorsal view. Fig. 37, edge view. Fig. 38, ventral view.

Figs. 39–41. *Cibicides grossepunctatus*, sp.n. (No. 495). × 28. Fig. 39, edge view. Fig. 40, ventral view. Fig. 41, dorsal view.

Figs. 42–45. *Cibicides lobatulus* (Walker and Jacob), pauperate variety (No. 489). × 45. Fig. 43, dorsal view. Figs. 42, 44, 45, ventral view.

Figs. 46–48. *Cibicides refulgens* Montfort var. *corticata*, var.n. (No. 488). × 26. Fig. 46, ventral view. Fig. 47, dorsal view. Fig. 48, ventral view of an abnormal wild growing specimen.

PLATE VIII

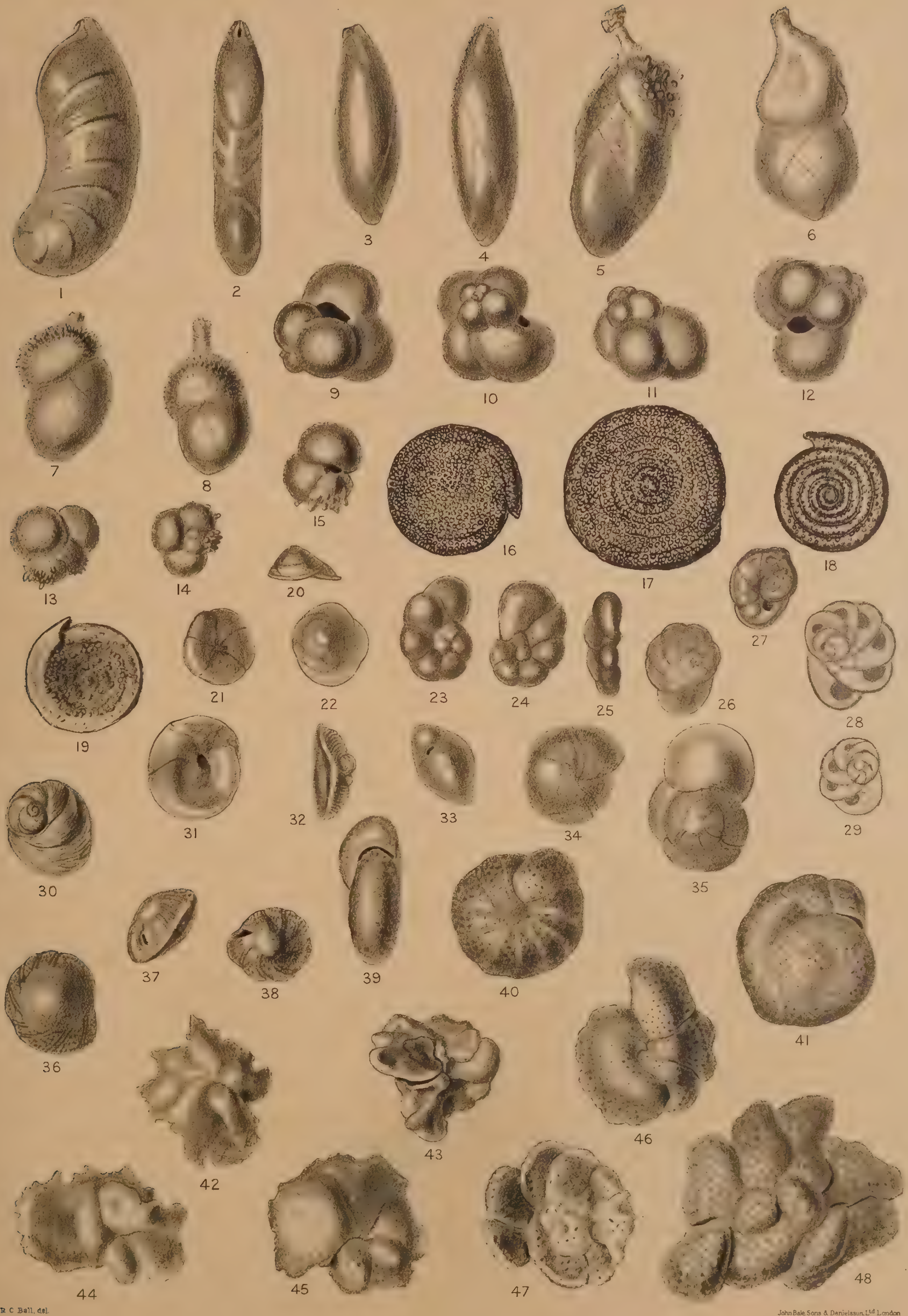
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PLATE IX

Fig. 1. *Miliolina insignis*, Brady (No. 25). × 13. Abnormal specimen. Front view. For other views see Plate I, figs. 1, 2.

Fig. 2. *Planispirina sphaera* (d'Orbigny) (No. 34). × 13. Aperture of a large specimen.

Figs. 3, 4. *Pelosphaera cornuta*, Heron-Allen and Earland (No. 49). × 12. See also Plate I, fig. 12.

Figs. 5–7. *Pelosina arborescens*, Pearcey (No. 55). × 4½. Fig. 5, typical. Figs. 6, 7, slender forms approaching *Pelosina variabilis*, Brady.

Figs. 8–10. *Pelosina variabilis* var. *constricta*, Earland (No. 54). × 2½.

Figs. 11–13. *Pilulina jeffreysii*, Carpenter (No. 68). × 6½. Fig. 11, apertural view. Fig. 12, side view. Fig. 13, abnormal double specimen with an aperture at each end. See also Plate I, fig. 18.

Figs. 14–19. *Thurammina spumosa*, sp.n. (No. 106). × 30. Fig. 14, interior view of a broken specimen showing perforations in wall. Fig. 15, a specimen with the cavernous layer partly removed, showing the projecting tubules. Fig. 16, an eroded specimen showing the cavernous layer. Figs. 17–19, almost perfect specimens showing the delicate outer layer produced into points.

Fig. 20. *Hormosina lapidigera*, Rhumbler (No. 157). × 13.

Fig. 21. *Reophax sabulosus*, Brady (No. 152). × 13.

Fig. 22. *Reophax sabulosus*, Brady (No. 152). × 60. A portion of the exterior of the specimen, showing the loosely agglutinated method of construction with Radiolaria and diatoms.

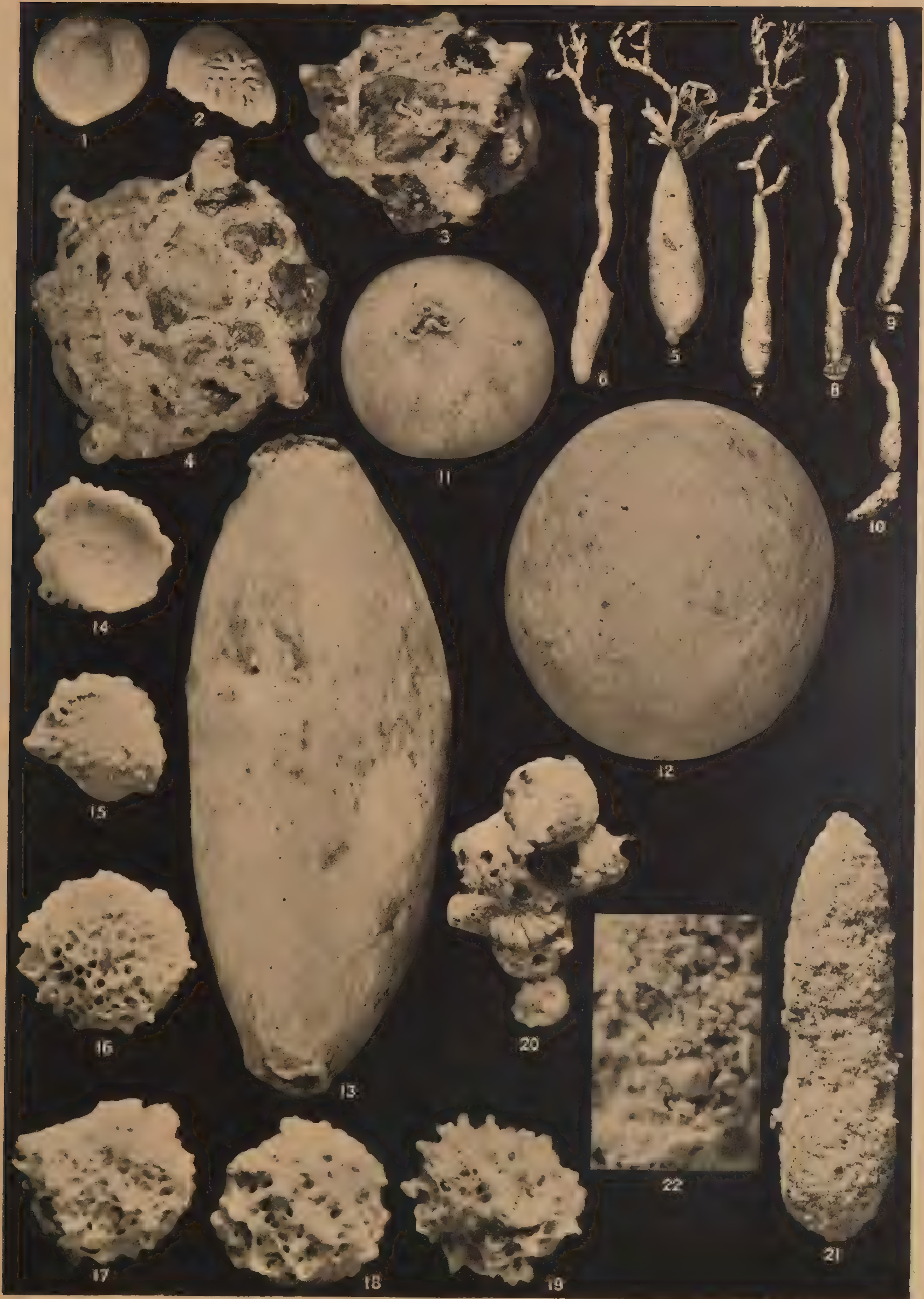
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PLATE X

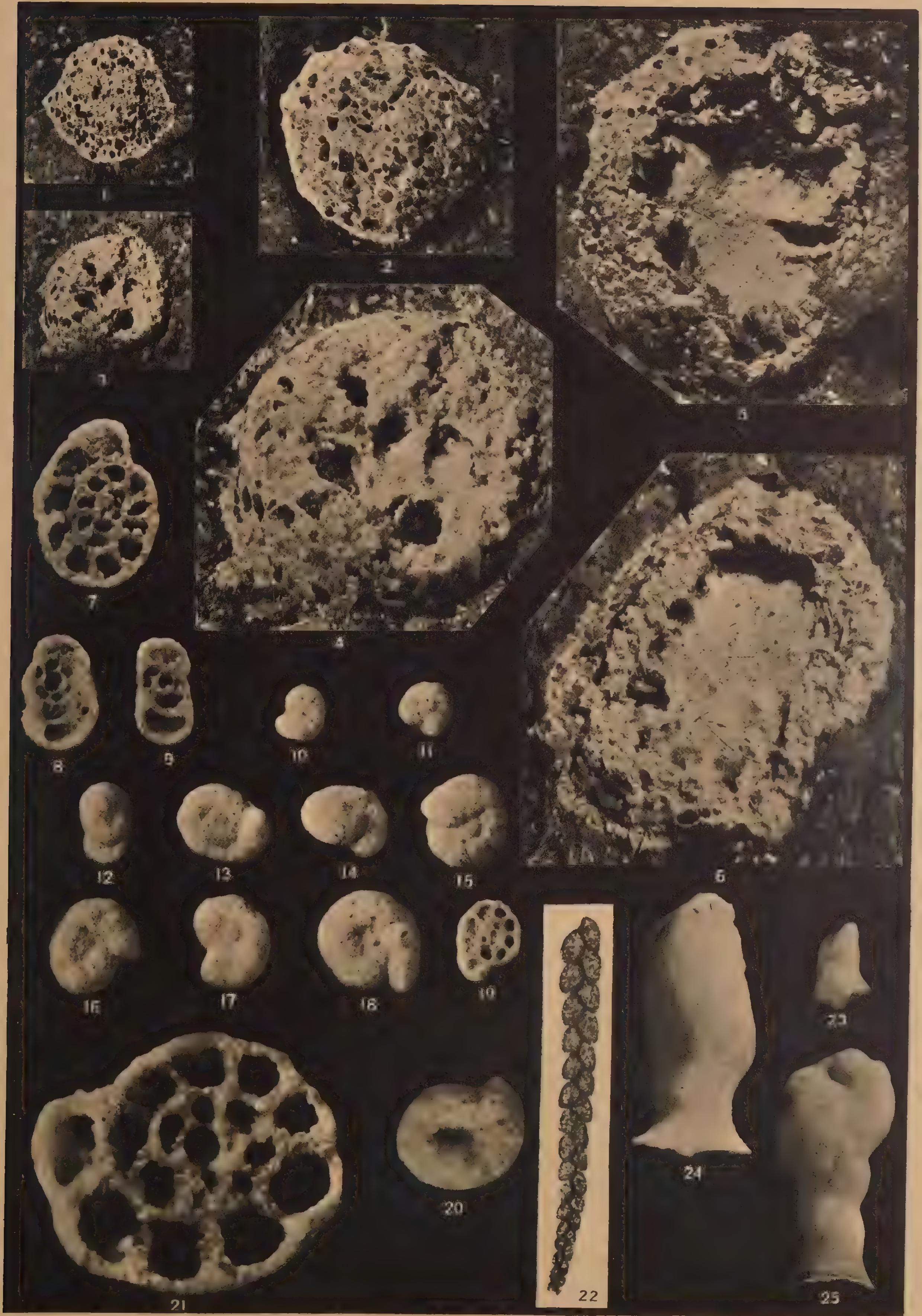
Figs. 1–6. *Webbinella farcta*, sp.n. (No. 93). Fig. 1, × 9. Fig. 2, another specimen, × 16. Fig. 3, a specimen laid open to show the interior packed with fine sand and the cavities occupied by separate protoplasmic bodies, × 9. Fig. 4, the same specimen, × 22. Fig, 5, a large abraded specimen showing the smoothly cemented floor of the test, with masses of dark protoplasm filling the recesses between the marginal flanges, × 13½. Fig. 6, another abraded specimen of irregular form showing the smooth floor and the marginal flanges, × 18.

Figs. 7–19. *Recurvoides contortus*, gen. et sp.n. (No. 169). Fig. 7, horizontal section of a microspheric specimen (not quite central), × 30. Fig. 8, vertical section of a megalospheric specimen (central), × 30. Fig. 9, vertical section of another megalospheric specimen (not central), × 30. Figs. 10–18, various stages of growth and position, × 19. Fig. 19, horizontal section of a megalospheric specimen, × 19.

Figs. 20, 21. *Haplophragmoides scitulus* (Brady) (No. 163). Fig. 20, × 70. Fig. 21, horizontal section of a megalospheric specimen, × 70. These two figures are for contrast with Figs. 7–19.

Fig. 22. *Textularia tenuissima*, Earland (No. 229). Slender variety; an imperfect specimen, × 134.

Figs. 23–25. *Rupertia stabilis*, Wallich (No. 496). × 26. Fig. 23, young stage. Figs. 24, 25, adult specimens viewed from opposite sides.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[*Discovery Reports*. *Vol. X*, *pp*. 209–245, *April*, 1935.]

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THE FALKLAND SPECIES OF THE CRUSTACEAN GENUS *MUNIDA*

BY

G. W. RAYNER, B.Sc.

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THE
FALKLAND SPECIES OF THE CRUSTACEAN GENUS *MUNIDA*

By G. W. Rayner, B.Sc.

(Text-figs. 1–18)

INTRODUCTION

In the course of a trawling survey of the continental shelf surrounding the Falkland Islands and fringeing the Argentine Patagonian coast, carried out by the R.R.S. 'William Scoresby' during the months October 1931 to April 1932, large numbers of the Anomurans, *Munida subrugosa* (White) and *Munida gregaria* (Fabricius) were taken. This survey was complementary to the trawling surveys previously carried out by the same vessel at different seasons during the years 1927 and 1928. At the same time it was more extensive, embracing as it did a much larger area and many more observations. The two species of *Munida* were met with far more frequently than on previous occasions and at times in very much larger numbers. The great importance of these two species in the bionomics of the area surveyed was still more fully realized, and although Matthews was then publishing his report, "Lobster Krill, Anomuran Crustacea that are the food of Whales" (Matthews, 1932), which dealt with the material from the two earlier surveys together with certain taxonomical and historical aspects, it was thought that the large amount of material being obtained would provide opportunity for further investigations on their respective life histories.

Both species are of considerable economic significance on the grounds surveyed, and they occur in certain areas in very great abundance. Matthews has shown that the free-swimming post-larval form of *M. gregaria*, the so-called *Grimothea*, is of prime importance as a food supply for the whalebone whales which are to be found in this area, whilst Hamilton (1934) stresses the part played by *Munida* in the diet of the southern sea lion, *Otaria byronia*. Hake, *Merluccius gayi*, taken in the trawl, were frequently found to be subsisting entirely on these creatures, and many birds eagerly feed upon them. These two species of *Munida* fulfil in the economy of the Falkland Islands region a role similar to, but wider than, that of krill, *Euphausia superba*, in South Georgian waters.

Munida were found to be excellent eating in the ships of the expedition, and they are utilized as food in the small ports on the coasts of Chilean and Argentine Patagonia under the wide term "Camerones." It is possible that in the future they may acquire commercial importance, for more use could be made of them for human consumption.

The existence of a pelagic post-larval form in *M. gregaria* is of considerable biological interest, for, so far as we are aware, it occurs only in this one species of the genus *Munida*.

With the pelagic habit are correlated certain structural modifications of the third maxillipede, and these, as Matthews (1932) has shown, may in certain circumstances be retained until, or almost until, the attainment of sexual maturity.

Press of work in the field allowed but a cursory examination of fresh material to be made, and although many samples were preserved some hauls were discarded after only identifying, counting, sexing and examining for parasites. In the very large hauls of *M. subrugosa* which were occasionally taken only fractional samples could be handled, the rest being indiscriminately tossed overboard. The material, large as it is, was obtained incidentally in a scheme much larger in scope than the subject of this report, and it thus lacks much of the value of a collection planned with the object of obtaining information regarding the life histories of the two species. Only a few questions are solved in the following report, and the suggestions put forward must wait upon subsequent more searching investigations carried out with closer attention to the living animal.

Mention must be made here of a small but useful collection of post-larval *M. gregaria* from Otago Harbour, New Zealand, forwarded by the late Mr G. M. Thompson to Mr L. H. Matthews, through whose courtesy it came into the writer's hands.

LARVAL DEVELOPMENT

Larval forms of the genus *Munida* have been described by Sars (1890), Stephensen (1913), Williamson (1915), Stebbing (1919), Webb (1921), Gurney (1924), and Lebour (1930). Sars, Webb and Lebour describe the larva of *M. banffica*, Stephensen the larva of *M. tenuimana*, whilst Williamson deals with both these northern forms: Stebbing and Gurney are concerned with southern hemisphere forms. Stebbing describes and figures what purports to be a larval stage of *M. gregaria* collected by Vallentin at the Falkland Islands, but unfortunately the description is scanty and the figures almost useless. Gurney deals with a form taken by the 'Terra Nova' in New Zealand waters. Young (1925) mentions the hatching of larvae from the eggs of *M. gregaria* by Anderton, but only gives the hatching dates and no description.

The larval forms of *Munida* now to be discussed were collected in tow-nets and other nets during the trawling survey of 1931–2. In a series of forty-three oblique hauls with a 1 m. tow-net, taken between September 1931 and April 1932, at depths of from 139 to 29 m. to the surface, fourteen contained larval forms and three early post-larval forms. The larval forms were taken in the months September to November and in February, but the early post-larvae were limited to January. Hauls in which larvae were not present were made in every month from September to April, except December.

Graphs showing the percentage of berried females to the total number of females in the monthly catches of *M. gregaria* and *M. subrugosa* have been prepared in the hope that the spawning periods would be indicated. The graph for *M. gregaria* (Fig. 1) shows a rapid descent from a high figure in October to zero in November, and this may be taken as indicating the shedding of larvae into the plankton. This spawning time corresponds with September and October given by Young (1925) as the spawning date of New Zealand *M. gregaria* kept under observation in captivity. The catches of *M. gregaria* were, however, scanty in November and December, and the conclusion that this definite spawning season occurs would be unwarrantable were it not supported by the frequency of *Munida* larvae in the plankton during September and October and by Young's observation.

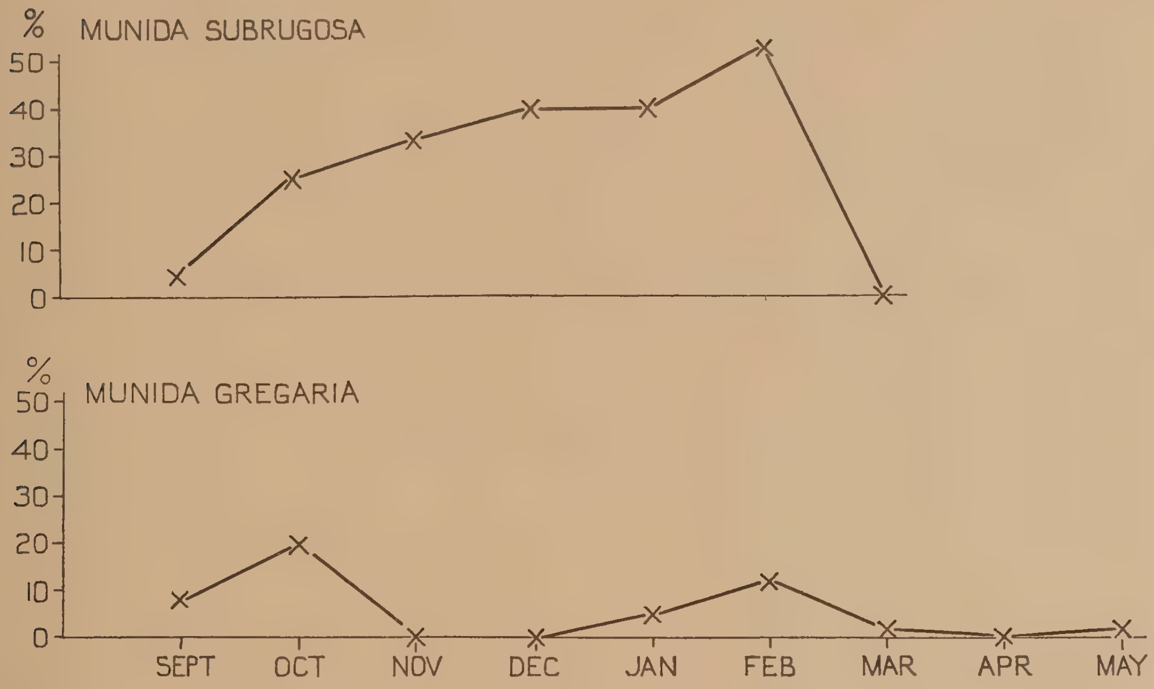

Fig. 1. Percentage of berried females to total catch of females in *Munida subrugosa* and *M. gregaria*.

Berried females again appear in the January and February catches in increasing numbers, but a fall occurs in March and April. It seems probable that females are again beginning to bear eggs after spawning in September and October, but that the hauls made in March and April, in which the catches of *M. gregaria* were only small, have failed to sample this part of the population.

Should spawning take place in September and October—which seems certain—and should eggs be extruded on to the pleopods in January and February—which seems probable—a period of eight months must be assigned to egg-carrying on the part of the female, a length of time which may be compared with ten months in the case of the American lobster, *Homarus americanus* (M.-Edw.), Herrick (1895).

In these circumstances, unless several months or a whole year are passed without breeding, the adult female can seldom, if ever, undergo more than one moult per year, the moult taking place between the time of hatching of the eggs and the resumption of egg bearing, i.e. October to January. The probability that long resting periods elapse between successive reproductive phases in the individual is upheld by the low percentage of berried females to the total population at any time. Such resting periods would enable growth and moulting to be free of the restricting egg-carrying condition for long intervals.

The spawning time of the second species, *M. subrugosa*, is less easy to determine. The graph (Fig. 1) showing the percentage of berried females in this species indicates a possible shedding of larvae in February; for after climbing to a pronounced peak in that month it shows a sudden drop to zero in March which persists in April and May. The paucity of *Munida* larvae in the plankton during February (three present in two hauls out of six) and their total absence in March and April makes spawning at this time of the year unlikely. No date, therefore, can be given for the spawning of *M. subrugosa*, but the likeliest time for this event would seem to be in early summer, in September and October, as in *M. gregaria*, a time when large numbers of *Munida* larvae are present in the plankton. Eggs obtained from ovigerous females taken on September 20 and October 13 contained well-developed embryos, but those of females captured on September 5 showed no indication of an embryo. It may be then that the spawning time of *M. subrugosa* is more variable than that of *M. gregaria*, and that larvae are shed into the plankton all through the summer.

In the series of larval *Munida* which has been examined it has not been possible to recognize two forms to correspond with the two species that are to be found in the adult condition in the area, and it is possible that the differences between the larvae of these two species are so small as to be imperceptible. Certainly the differences between the very earliest post-larvae, before the modification of the external maxillipede in *M. gregaria*, are such as to make distinction at this stage difficult or even impossible, and considering the close resemblance and relationship of the two species, a very marked similarity or even morphological identity of the two larval forms would not be surprising.

The Falkland Islands *Munida* larvae resemble the other described forms to a marked degree, but they can be distinguished by a different spinulation of the posterior dorsal margins of the abdominal segments. Five larval stages are here described, differentiated primarily by the spines of the telson.

STAGE I (Fig. 2*a*)

The two spines on the posterior dorsal margins of the second to fifth abdominal segments in the first stage of *M. banffica* are replaced in the Falkland larvae by four prominent spines, in the spaces between which are two smaller spines. Laterally to the outer larger spines are one or two smaller spines, making twelve to fourteen in all. The fourth and fifth abdominal segments each carry two strong lateral spines exactly similar to those present in *M. banffica*. The first abdominal segment carries a row of very fine spinules on its posterior dorsal margin, a feature common to the more posterior segments of the larvae of *Galathea*.

This is the stage figured by Gurney (1924) from a specimen taken north of Three Kings Islands, New Zealand. His figure shows features very much like the Falkland

Islands form, especially in the large number of spines on the abdominal segments. Differences exist in the arrangement of these spines, in the shape of the antennal scale and in the presence of spines on the whole length of the posterior margin of the carapace.

The aciculate form of the antennal scale given by Lebour (1930) as a generic character of *Munida* and stressed as such by Gurney (*loc. cit.*) is more pronounced in previously described forms than in the Falkland Islands larvae. Although approaching *Galathea* in this feature, these larvae belong indisputably to the genus *Munida*, *Galathea* not being known to occur in the area. The distinguishing character of the larvae of the two genera is the palp of the first maxilla—not the second as given by Lebour (1930)—which is composed of one segment in *Munida* and of two in *Galathea*. The aciculate form of the antennal scale, as figured by Gurney and Lebour, cannot, therefore, be looked upon as a generic feature, and it would seem probable that the two genera merge one into the other in this respect.

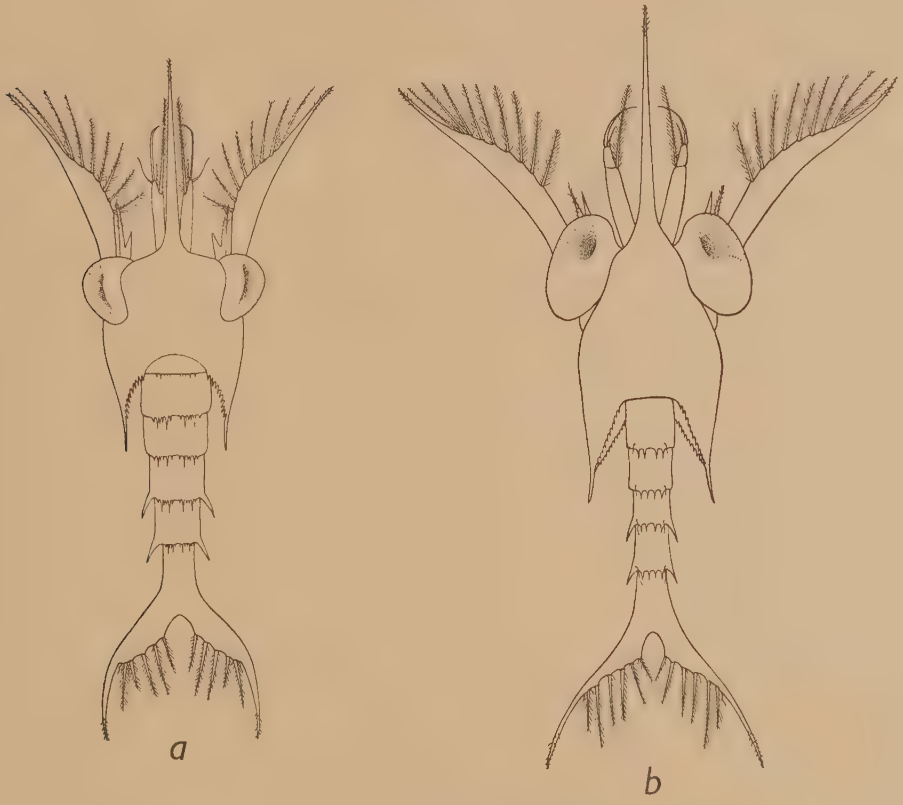

Fig. 2. Larval stages of *Munida*.

a. First stage, length 3·0 mm. *b.* Second stage, length 4·0 mm.

The rostrum and the postero-lateral spines of the carapace are not as long in the Falkland larvae as in *M. banffica* larvae, characters showing an approach to the larvae of *Galathea*. The telson remains the same as in the northern species, having seven spines on either side, the second being insignificant and hair-like. The total length from tip of rostrum to the cleft of the telson of the specimen figured was 3·0 mm., considerably smaller than the corresponding size in *M. banffica*.

STAGE II (Fig. 2*b*)

This is a stage not figured by Lebour (1930) for *M. banffica*, although described in her text; it differs from stage I and also from her second larva in the possession of eight spines on either side of the telson. A second and important change is in the spinulation of the postero-dorsal margins of the abdominal segments. The postero-dorsal margin of the first segment is now smooth, whilst only the four large spines remain in this position on the second to fifth segments. The strong lateral spines persist on the fourth and fifth abdominal segments. On each segment bearing dorsal spines small hairs arise slightly anterior to the base of the outer of these spines. The antennal scale now carries nine plumose hairs instead of eight, and the antennule is composed of two segments. The shape of the carapace has become modified, giving the eyes greater prominence, and the importance of the fourth spine of the telson is foreshadowed in its increasing size. The total length of the specimen figured was 4·0 mm.

STAGE III (Fig. 3*a*)

The division of the sixth abdominal segment from the telson and the appearance of the uropods mark a strong advance in the development of the larva. The number of spines on either side of the telson is increased to nine, the fourth equalling the first in size and now fused with the telson. The outer branch of the uropod carries ten plumose hairs, the inner branch being still non-setose. The sixth abdominal segment carries a stout mid-dorsal spine only. The dorsal spines of the preceding four segments are reduced in size, the fourth segment carrying the largest. The hairs on the antennal scale are increased to ten. The prickles previously present on the tip of the rostrum, on the tips of the antennal scales and on the tips of the first spines of the telson have disappeared. The total length of the specimen figured was 5·5 mm.

STAGE IV (Fig. 3*b*)

A great reduction in the size of the outer spines of the telson, the fourth now being predominant, and an increase in the total number to eleven, mark this stage. The inner branch of the uropod carries seven plumose setae and the terminal seta of the outer branch has become spinose and fused. The second abdominal segment has lost all spines, and those on the postero-dorsal margins of the third to the fifth segments are again reduced in size. The proximal segment of the antennule has lost the stout seta it previously carried and this has been replaced by one arising lower down. The distal segment of the antennule carries more aesthetes on its inner side. The number of hairs on the antennal scale is again increased and is now fifteen. The number of teeth on the posterior margin of the carapace is reduced. The total length of the specimen figured was 8·0 mm.

STAGE V (Fig. 3*c*)

A further increase to twelve occurs in the number of spines of the telson. The uropods are more setose and the inner branch is larger. Only two spines are present on the postero-dorsal margins of the third and fourth abdominal segments, although four still persist on the fifth. Simple biramous pleopods are present on the second to fifth abdominal segments. The teeth on the posterior border of the carapace are reduced to only four or five. Fine teeth are now present on the dorso-lateral margin of the proximal portion of the rostrum. The antennal scale carries seventeen plumose hairs and the antennule has many more aesthetes on the terminal segment. The total length of the specimen figured was 8·5 mm.

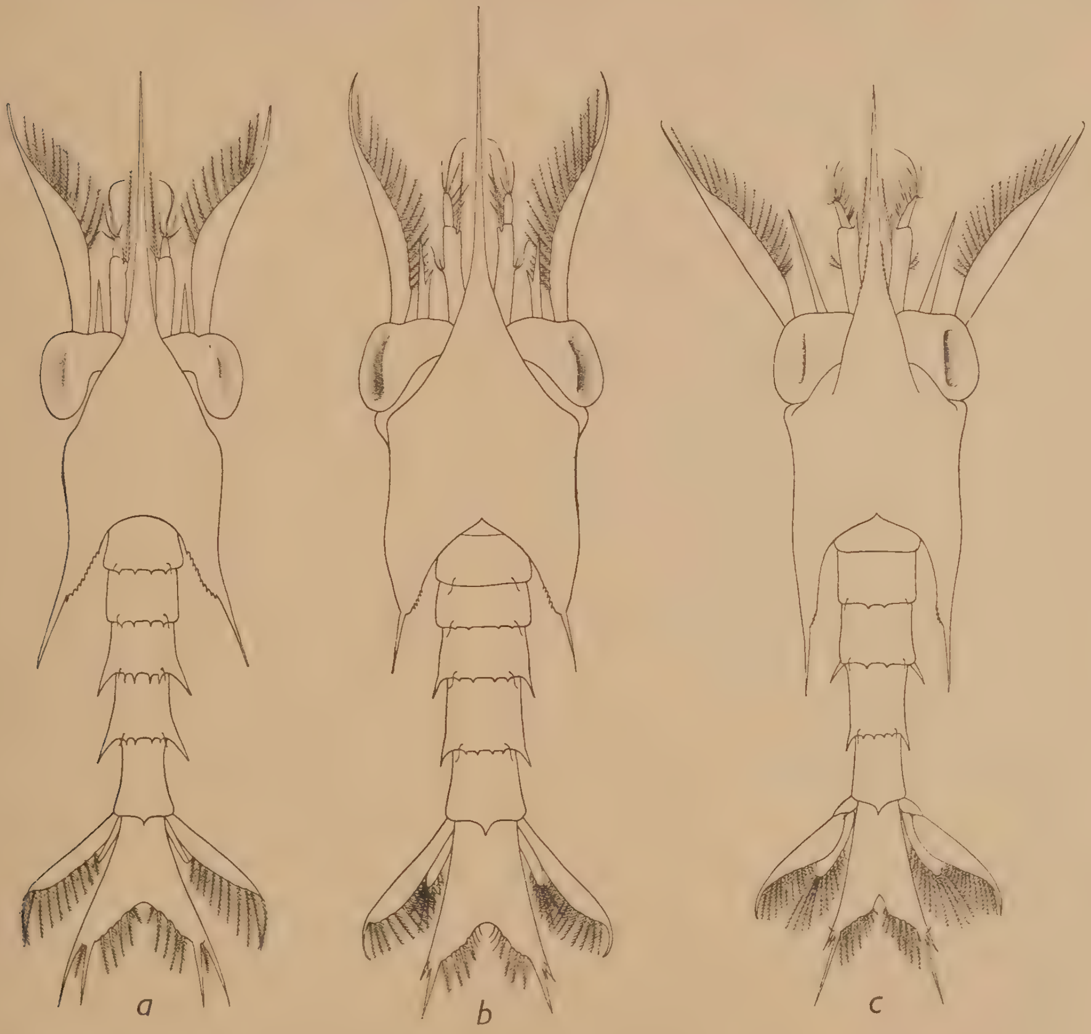

Fig. 3. Larval stages of *Munida*.

a. Third stage, length 5·5 mm. *b*. Fourth stage, length 8·0 mm.
c. Fifth stage, length 8·5 mm.

This may or may not be the last larval stage, but comparison with the last stage of *M. banffica* makes it very probable that a post-larval form follows. If the foregoing five stages can be looked upon as separate and comparable with the four stages of *M. banffica*, a further resemblance to *Galathea*, where five stages are known at times to occur, is presented. A certain amount of variation occurs within each stage, principally in the number of hairs on the antennal scale.

The post-larvae, apart from one or two structures which have yet to be modified, such as the pleopods, have the form of the adult. In consequence of their small size distinction between the two species is difficult at first, but the difference in the length of the eye stalk and the modification of the third maxillipedes in *M. gregaria* soon become apparent. The rostrum has not at first a single point as in the adult, but in the earlier post-larvae the tip of the rostrum has the appearance of a trident with the two lateral spines longer than the central spines. Later, the central spine is increased in length and the two lateral spines become subsidiaries, whilst other small spines have made their appearance along the sides of the rostrum. In the *Grimothea* stage of *M. gregaria* many more lateral spines have arisen, giving to the edges of the rostrum a toothed appearance; from the base of each tooth springs a single, short, stiff hair. These lateral teeth are retained in the adults of both species, but with the greatly increased size of the rostrum they become overshadowed and insignificant.

DEVELOPMENT OF PLEOPODS IN *MUNIDA SUBRUGOSA*

The appearance, in the fifth larval stage, of the pleopods on the abdominal segments as very simple biramous appendages has already been mentioned above. Later, in the early post-larval stage, when the young *M. subrugosa* has acquired the general adult structure, the pleopods of the second to fifth segments still display the biramous form, thus differing considerably from the adult of either sex. The typical pleopod at this stage, when the carapace has a length of 3–4 mm., consists of a large stout protopodite carrying an endopodite and an exopodite (Figs. 4*a–d*). The endopodite is a small, simple segment attached to the inner distal corner of the rectangular-shaped protopodite. The expodite, on the other hand, is much larger and carries about fourteen long, strong and heavily plumose setae. Two of these are arranged close together at the extreme tip, and of the remainder six are placed along each side; at times, five or seven may occur instead of six. The setae spring from collars articulating with the exopodite. The surface of the exopodite is sculptured with conchoidal depressions opposite these articulations, giving the body of the exopodite, with its subconical shape, the appearance of a pineapple.

In the next stage examined (Figs. 4*e–h*) the pleopods have entirely changed in character. Considerable reduction has taken place, although the size of the protopodite is greater relative to the size of the exopodite and endopodite. The inner edge of the protopodite remains straight, but the outer has become markedly convex and now carries six to ten stout plumose setae. The exopodite has changed considerably. It has

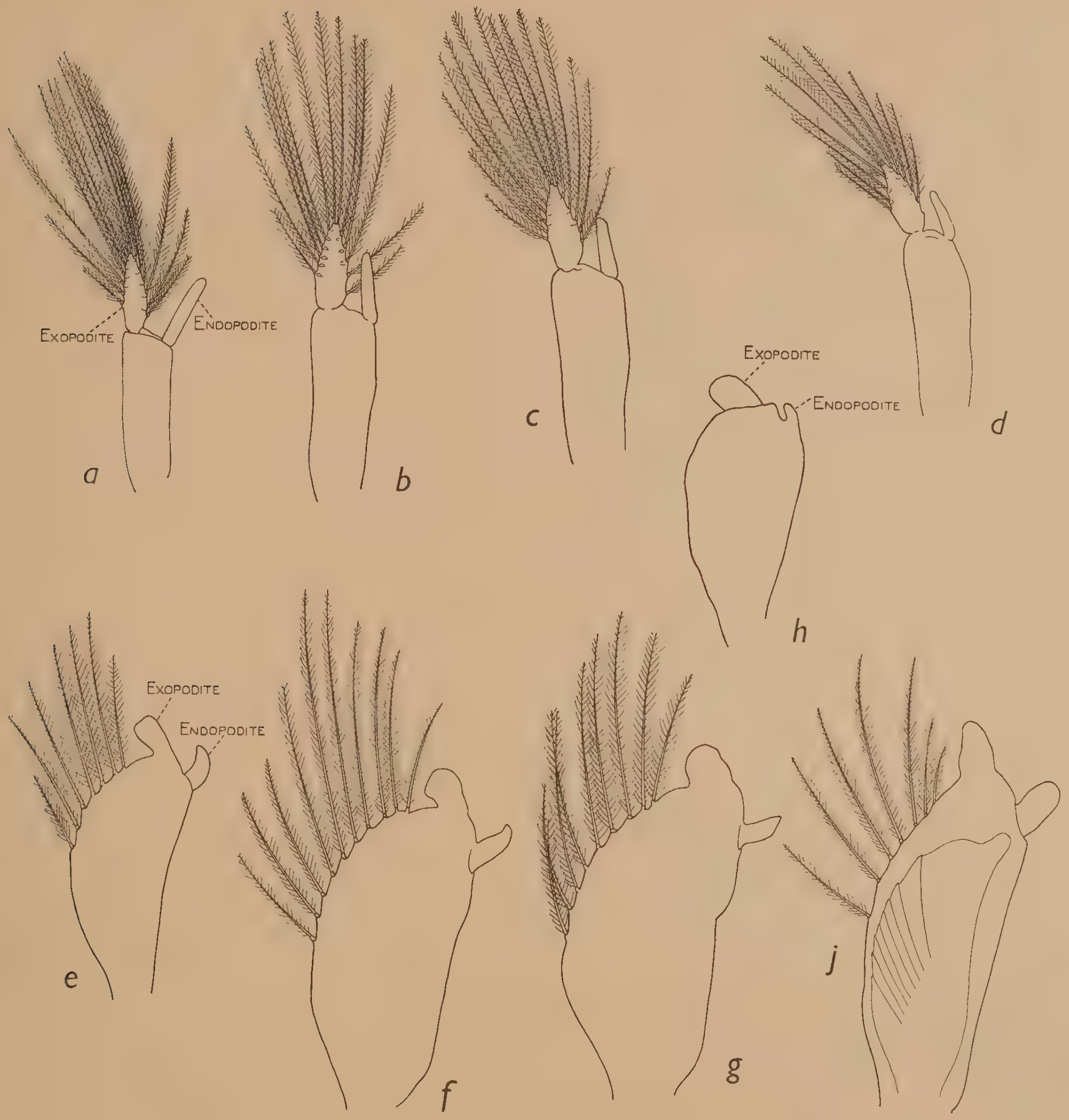
Exopodite
Endopodite
a
b
c
Exopodite
Endopodite
d
h
Exopodite
Endopodite
e
f
g
j

Fig. 4. Development of pleopods in *Munida subrugosa* (*a–h*) and *M. gregaria* (*j*).

a. Fifth pleopod, first stage.
b. Fourth pleopod, first stage.
c. Third pleopod, first stage.
d. Second pleopod, first stage.
e. Fifth pleopod, second stage.
f. Fourth pleopod, second stage.
g. Third pleopod, second stage.
h. Second pleopod, second stage.
j. Fourth pleopod, late second stage.

In each figure the left pleopod is shown. Figs. *e–j* are to a scale $2\frac{1}{2}$ times greater than Figs. *a–d*.

shrunk to a very great extent and has lost the whole of its plumose setae. Its shape is ill defined and irregular and it appears merely as a lobe at the extremity of the protopodite. The endopodite is also very much smaller than before and it now projects like a horn a little way down the inner border of the protopodite. The pleopods of the third to fifth abdominal segments have this form, but that of the second abdominal segment has altered to a more marked degree and the ultimate simple two-segmented female form is already strongly foreshadowed. The protopodite, carrying no setae, is much smaller than in the succeeding pleopods and the endopodite and exopodite project from the end as two lobes, the exopodite being the more prominent (Fig. 4*h*). Specimens of this stage preparing for ecdysis and identified as *M. gregaria*, showed the flat, foliaceous pleopod of the next stage so outlined as to demonstrate that the original exopodite would be suppressed and the endopodite retained (Fig. 4*j*).

When this ecdysis is completed, the third, fourth and fifth pleopods are flat and expanded (Figs. 5*a–c*). The inner edge is straight or slightly concave, whilst the outer is convex and carries articulating plumose setae to the number of nine to twelve. This is the part corresponding to the protopodite of the earlier biramous pleopod. Articulated to this, at the junction of the inner straight and outer curved borders, is the relic of the endopodite appearing as a simple, short projection, the exopodite having entirely disappeared. The appendage of the second abdominal segment (Fig. 5*d*) consists merely of a two-segmented process of a very simple nature.

The foregoing account describes the course of growth in both sexes, but at this stage in the male the development of the third to fifth pleopods is arrested except for progressive increase in size. The pleopods of the second segment together with those of the first, which have yet to appear, metamorphose to become the copulatory appendages before the adult form is fully realized.

The pleopods of the female, with the exception of those of the second segment, which already have almost their final shape, have to become modified considerably in order to attain the adult egg-carrying form. This form is attained by the loss of the lobe of the protopodite, by extension of the endopodite and by a considerable lengthening and stiffening of the whole limb, together with the growth of hairs to which eggs will be attached. Pérez (1927) has described this post-larval metamorphosis of the female pleopods in *Galathea* and states that the same change takes place in *Munida*. He says that the small finger-like terminal process of the protopodite is composed of two segments in the male, whereas in *M. subrugosa* it is composed of only a single segment; and, though giving no evidence for his statement, he asserts that this is a rudimentary endopodite. The process is in fact an endopodite, but it should rather be looked upon as a degenerate endopodite, whilst the exopodite has been completely aborted. Selbie (1914) mentions male *Galathea intermedia* with this endopodite composed now of one segment and now of two.

In our species the change in the form of the female limbs takes place from the most posterior segment anteriorly, as though the centre of the metamorphic activity were situated in the fifth abdominal segment and gradually extended forward. When the

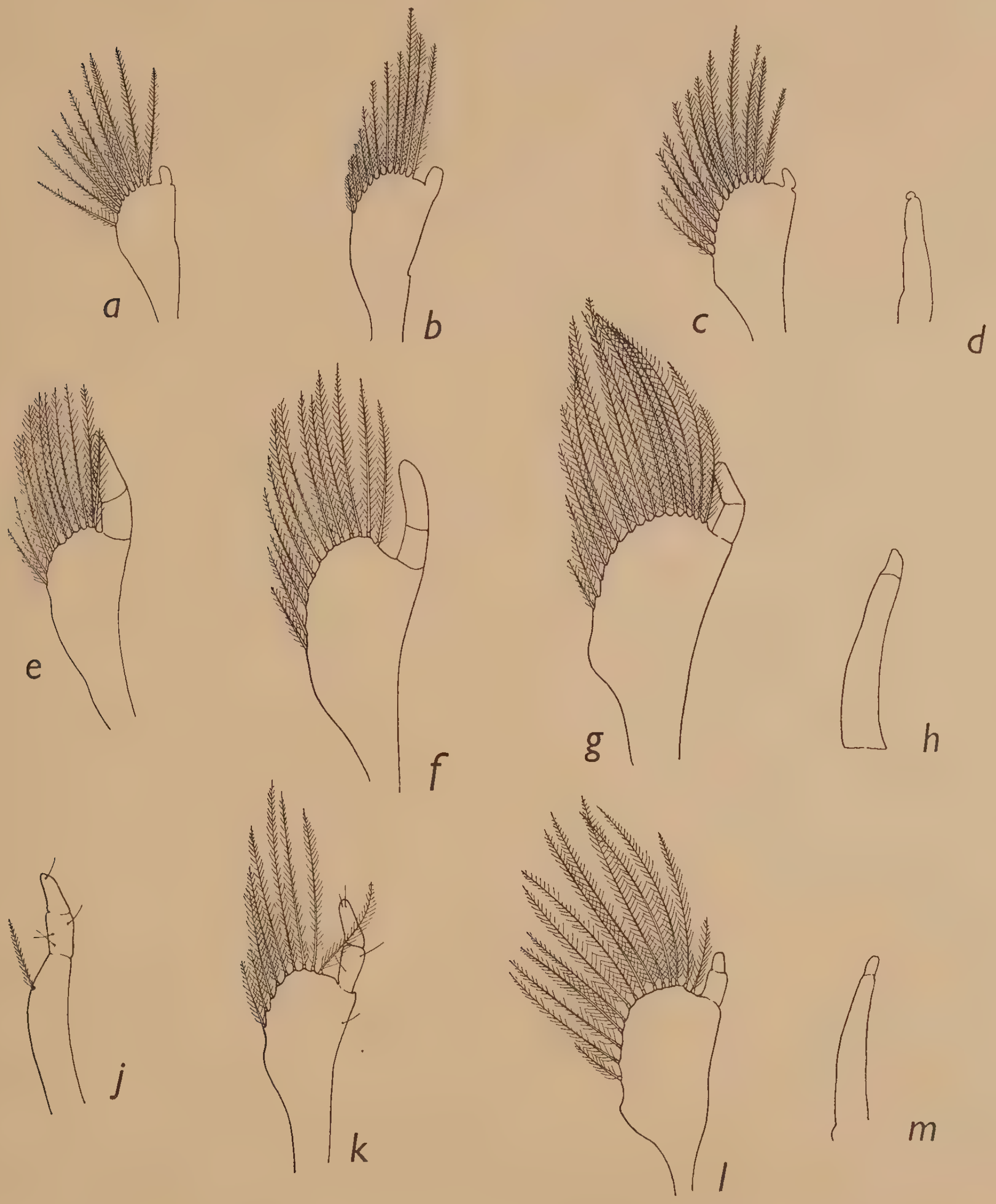

Fig. 5. Development of pleopods in *Munida subrugosa*.

a. Fifth pleopod, third stage.
b. Fourth pleopod, third stage.
c. Third pleopod, third stage.
d. Second pleopod, third stage.
e. Fifth pleopod, fourth stage, female.
f. Fourth pleopod, fourth stage, female.
g. Third pleopod, fourth stage, female.
h. Second pleopod, fourth stage, female.
j. Fifth pleopod, fifth stage, female.
k. Fourth pleopod, fifth stage, female.
l. Third pleopod, fifth stage, female.
m. Second pleopod, fifth stage, female.

In each figure the left pleopod is shown, All the figures are to the same scale.

differentiation of the female pleopods commences, at a carapace length of 10–12 mm., the small endopodite increases in size and becomes two-segmented (Figs. 5*e–g*), whilst the lobe of the protopodite of the fifth pleopod is slightly reduced (Fig. 5*e*). The following stage shows this lobe almost gone (Fig. 5*j*) and, in the specimen figured, with only a single plumose hair remaining of the dozen or so previously present. A few, short, stiff, non-plumose hairs, the rudiments of the egg-carrying hairs, are present on the two distal segments. The lobes of the pleopods of the fourth abdominal segment (Fig. 5*k*) are slightly reduced and egg-carrying hairs appear on the endopodite. The

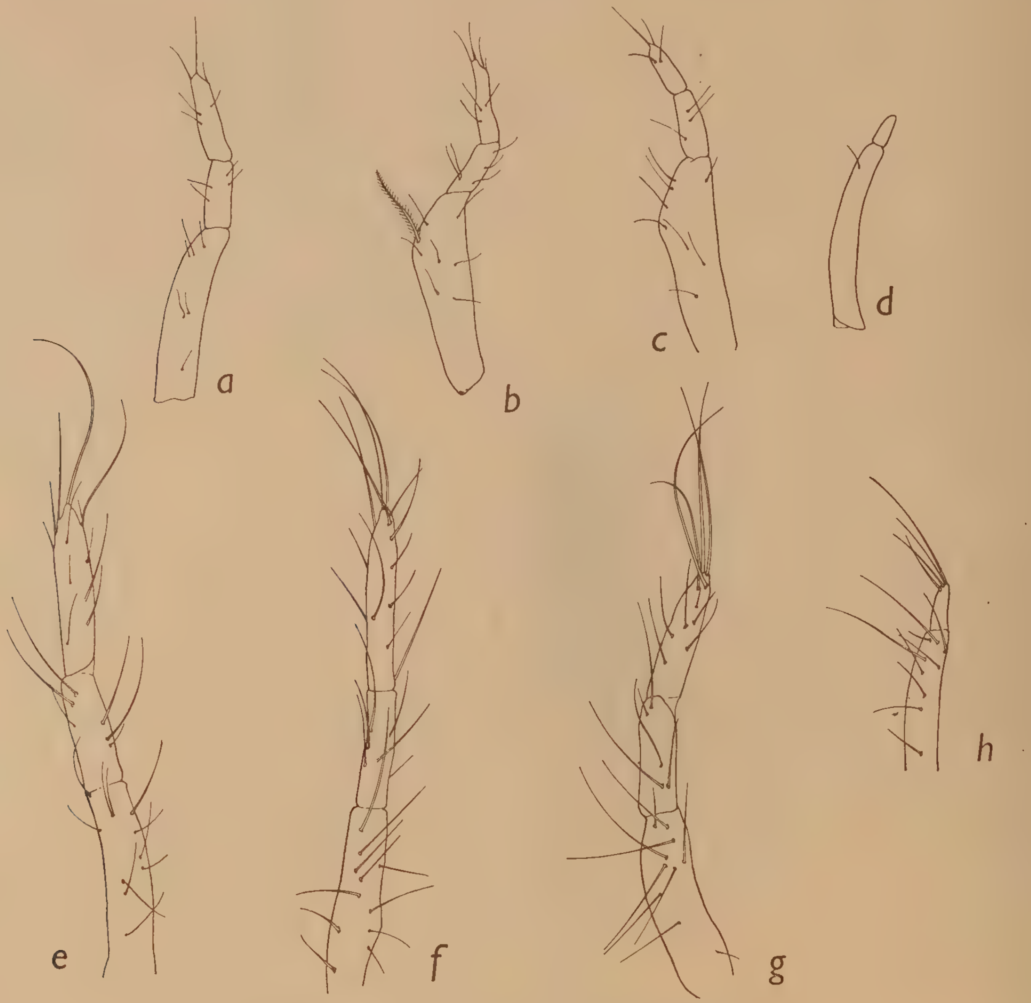

Fig. 6. Development of pleopods in *Munida subrugosa*.

a. Fifth pleopod, sixth stage, female.
b. Fourth pleopod, sixth stage, female.
c. Third pleopod, sixth stage, female.
d. Second pleopod, sixth stage, female.
e. Fifth pleopod, seventh stage, female.
f. Fourth pleopod, seventh stage, female.
g. Third pleopod, seventh stage, female.
h. Second pleopod, seventh stage, female.

In each figure the left pleopod is shown. All the figures are to the same scale.

pleopods of the third segment (Fig. 5*l*) remain as before, as do those of the preceding segment (Fig. 5*m*).

The next advance in development shows the pleopods of the fifth segment approaching the final form (Fig. 6*a*). All sign of the protopodal lobe has disappeared, the whole limb is stouter and more elongated and supports more egg-carrying hairs. The third and fourth pleopods still show a slightly lobose protopodite, and although the egg-carrying hairs are now abundant, a plumose seta still remains on the fourth pleopod which is figured (Fig. 6*b*). The pleopods of the second abdominal segment (Fig. 6*d*) are now stiffer and are beginning to carry hairs. Finally the adult form is realized (Figs. 6*e–h*) and only growth, strengthening of the limb and greater proliferation of the ovigenous hairs are required.

In the male the pleopods of the first and second segments are modified to act as copulatory appendages. In the late larval and early post-larval stages no appendage is to be found on the first abdominal segment in either sex. In the male, however, with the commencement of the modification of the second pleopods to form copulatory appendages, the supplementary copulatory appendages on the first segment make their appearance. The appendages of the second segment are present in the early post-larval stages as biramous pleopods (Fig. 4*d*), similar to those of the succeeding segments, and later they degenerate to a protopodite with two projections representing the endopodite and exopodite as already described (Fig. 4*h*). In the female, the exopodite disappears and the endopodite persists in very simple form. The degenerate exopodite, however, persists in the male, whilst the endopodite takes on a considerably modified form.

The form of the second pleopod shown in Fig. 4*h* is followed, in the male, by that depicted in Fig. 7*a*, and it consists of a simple protopodite bearing a simple styliform endopodite and a very small bud representing the exopodite. Fig. 7*c* shows further development; an increase in size has taken place; especially of the endopodite, whose distal half is now flattened and carries a border of short stiff hairs. A keel runs along the proximal half, and the flattened distal part appears to have been twisted on this portion. Development continues by the expansion of the flattened spatulate tip of the endopodite and the thickening and strengthening of the proximal stalk-like part. The exopodite increases in size and projects as a very simple, single segment. Fig. 7*e* shows what is almost the mature adult form. The whole limb is very much larger. The endopodite is large and expanded, and is bordered by short, stiff hairs, with a bunch of these covering one corner. The exopodite is rigid and acts as a stop to the free movement of the endopodite in a lateral direction.

The appendage of the first abdominal segment of the male first appears as a very simple limb of two segments (Fig. 7*b*), the proximal being long and curved with a small terminal segment. It is this terminal segment which undergoes the most modification before the limb achieves its final form. Fig. 7*d* shows it lengthening and becoming slightly turned at the tip; one or two hairs have made their appearance. The tip then expands with one side curved and one side straight, giving a prow-like termination to the limb (Fig. 7*f*). In the final form (Fig. 7*h*), the protopodite is curved and strong and from a corner at its distal extremity springs a group of particularly long setae. The prow-like shape of the distal segment is further accentuated and, indeed, exaggerated.

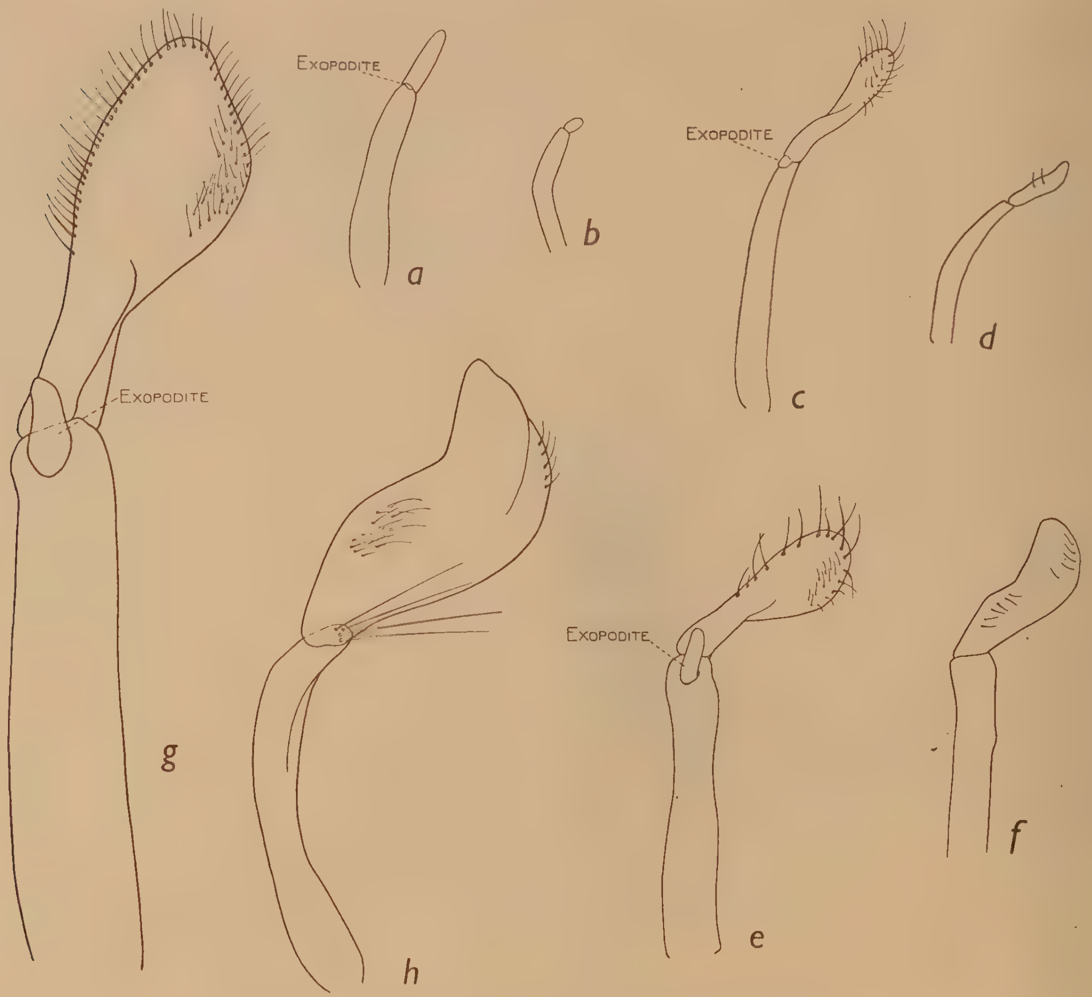

Fig. 7. Development of pleopods in *Munida subrugosa*.

- *a*. Second pleopod, fourth stage, male.
- *b*. First pleopod, fourth stage, male.
- *c*. Second pleopod, fifth stage, male.
- *d*. First pleopod, fifth stage, male.
- *e*. Second pleopod, sixth stage, male.
- *f*. First pleopod, sixth stage, male.
- *g*. Second pleopod, adult male.
- *h*. First pleopod, adult male.

In each figure the left pleopod is shown. All the figures are to the same scale.

It is not suggested that these stages described in the development of the pleopods indicate different and successive moults or hard and fast stages. Variation occurs in the combination of the different stages of development of the limbs, but invariably the more posterior the limb the farther is it advanced in development. The stage at which the limb may have arrived does not depend entirely upon the size of the animal, and although there is a general advance in size according to the stage reached, considerable overlap occurs. In the female specimens figured, for example, the most advanced stage (Figs. 6*e–h*) had a carapace length of only 9·3 mm., whereas the preceding stage figured (Figs. 6*a–d*) had a carapace length of 12·0 mm.

The course of development of the pleopod here outlined for *M. subrugosa* is followed in almost identical fashion by *M. gregaria*. In the final form of the pleopods no distinction between the two species is to be found.

GROWTH

In the hope of obtaining an indication of the growth rates of *M. subrugosa* and *M. gregaria*, measurements of the length of the carapace of all the specimens brought home and now in the Discovery collections have been made. The measurement taken was from the mid-dorsal point of the posterior margin of the carapace, where a slight indentation usually occurs, to the tip of the rostrum. The measurements were made in millimetres by means of vernier callipers, and such measurements as included fractional parts were referred to the integer immediately below. The smaller specimens (less than 15 mm. in length of carapace) were first measured in half-millimetres, but later these were grouped in millimetres so as to conform to the rest. For the purpose of drawing the frequency curves the measurements have again been grouped into two millimetre classes.

The numbers of specimens measured were *M. subrugosa* 4457, *M. gregaria* 1951 from the Falkland Islands region and, in addition, 137 immature specimens of *M. gregaria* from New Zealand waters. The material, taken during the course of three trawling surveys and at other times, was obtained over a period of several years and, although large, it is not representative of every month of the year. Tables I and II show the times at which the specimens of *M. subrugosa* and *M. gregaria* were obtained from the Falkland Islands region. Table III gives the time distribution of *M. gregaria* from New Zealand waters. It will be seen that in the Falkland Islands region scarcely any specimens of either species were taken in June, July and August, and that the numbers of *M. gregaria* in October, November and December are negligible. In the ensuing discussion of the length frequencies for *M. subrugosa* the figures have been grouped into two-monthly time intervals. The June–July period is not represented, whilst the inadequate catches in April, August and November cause the curves for the corresponding bi-monthly periods to be not wholly representative of the stock.

MUNIDA SUBRUGOSA

The bi-monthly length frequency figures of this species have been reduced to percentages, and with the values thus obtained the curves in Figs. 8 and 11 have been constructed. The principle followed in drawing these curves is that suggested by Wollaston (1929). The multimodal curve which would normally be obtained by drawing a smooth curve through the plotted points has been split up into individual "curves of error", each of which is considered to represent a distinct group in the total stock. In the figures each curve of error is shown in its entirety, and thus the catch of each bi-

Table I

Munida subrugosa

	1926		1927		1928		1929		1930		1931		1932		Totals	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Jan.	—	—	—	—	—	—	—	—	—	—	—	—	191	170	191	170
Feb.	—	—	29	28	—	—	—	—	—	—	—	—	236	327	265	355
Mar.	—	—	13	20	—	—	—	—	—	—	2	9	92	93	107	122
Apr.	—	—	20	15	—	—	—	—	—	—	12	4	—	—	32	19
May	33	38	—	—	6	5	—	—	—	—	7	9	—	—	46	52
June	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
July	—	—	—	—	6	4	—	—	—	—	—	—	—	—	6	4
Aug.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sept.	—	—	—	—	—	—	—	—	—	—	147	132	—	—	147	132
Oct.	—	—	—	—	—	—	—	—	—	—	951	851	—	—	951	851
Nov.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Dec.	—	—	—	—	—	—	—	—	—	—	522	485	—	—	522	485
Totals	33	38	62	63	12	9	—	—	—	—	1641	1490	519	590	2267	2190

Table II

Munida gregaria

	1926		1927		1928		1929		1930		1931		1932		Totals	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Jan.	—	—	—	—	—	—	—	—	—	—	—	—	185	304	185	304
Feb.	—	—	1	—	—	—	—	—	—	—	—	—	113	92	114	92
Mar.	—	—	30	43	—	—	11	20	—	—	—	—	1	1	42	64
Apr.	—	—	172	170	—	—	12	23	—	—	32	45	—	—	216	238
May	201	215	—	—	—	—	—	—	—	—	52	91	—	—	253	306
June	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
July	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Aug.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sept.	—	—	—	—	—	—	—	—	—	—	86	29	—	—	86	29
Oct.	—	—	—	—	—	—	—	—	—	—	2	4	—	—	2	4
Nov.	—	—	—	—	—	—	—	—	—	—	4	7	—	—	4	7
Dec.	—	—	—	—	—	—	—	—	—	—	2	3	—	—	2	3
Totals	201	215	203	213	—	—	23	43	—	—	178	179	299	397	904	1047

Table III

Munida gregaria from New Zealand

	1932		1933		Totals	
	♂	♀	♂	♀	♂	♀
Jan.	—	—	17	13	17	13
Feb.	—	—	8	10	8	10
Mar.	—	—	9	10	9	10
Apr.	—	—	—	—	—	—
May	—	—	—	—	—	—
June	—	—	—	—	—	—
July	—	—	—	—	—	—
Aug.	—	—	—	—	—	—
Sept.	—	—	—	—	—	—
Oct.	—	—	—	—	—	—
Nov.	22	16	—	—	22	16
Dec.	12	20	—	—	12	20
Totals	34	36	34	33	68	69

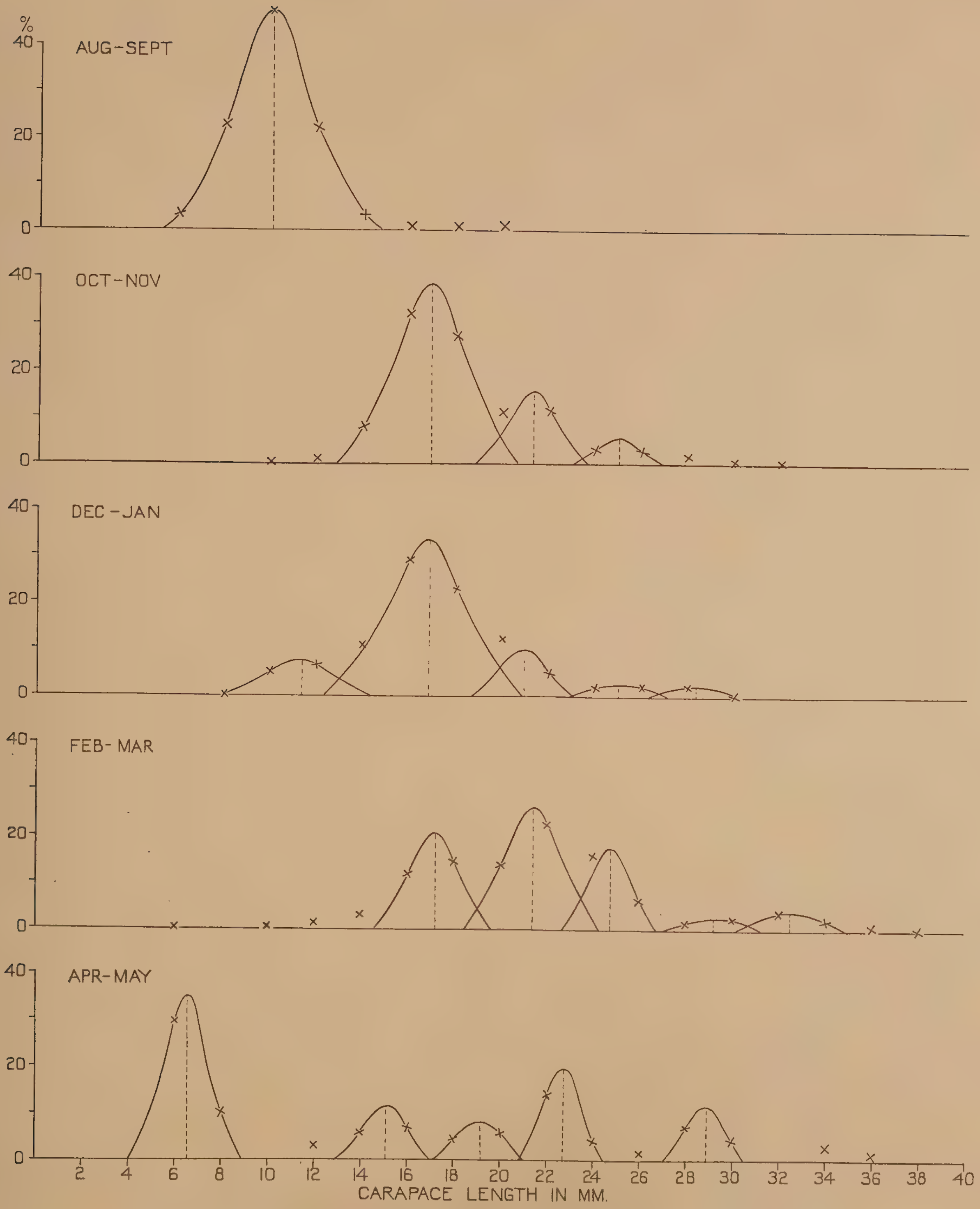

Fig. 8. *Munida subrugosa*, females. Bi-monthly graphs of carapace length frequencies reduced to percentages; each individual curve of error drawn in its entirety.

monthly period is seen to consist of a number of groups distinguished by definite modal lengths. The modal length of each separate curve of error, indicated in the figures by the perpendicular dropped from the modal point of each curve, has then been plotted on the circular graphs, Figs. 9 and 12. In these graphs the circles represent carapace lengths, the origin being at the common centre. The circles are placed 2 mm. apart and so correspond with the frequency classes of the curves of Figs. 8 and 11. The six equally spaced radii represent the six bi-monthly periods of the year, and along each radius have been plotted the modal lengths of each separate curve of error present in the corresponding bi-monthly graph. The values of these modal lengths are shown by crosses along the radii. Where a modal length is based upon less than 10 per cent of the total specimens for any period, its position is marked by a smaller cross than that employed for modal lengths based upon more than 10 per cent of the total specimens for the period. When all the modal lengths are thus plotted it is found that a smooth curve of ever-increasing radius can be drawn through the majority of the points. This curve is not a true helix, for the increase in radius is not constant; but it is a reasonably smooth curve passing through practically all the points without retrogression and may be termed subhelical. This curve illustrates the growth throughout the life of an average individual.

The curves thus obtained on the circular graph can be readily transferred to the usual rectangular form of graph as in Figs. 10 and 13. Here the bi-monthly periods are shown along one axis, carapace lengths along the other. The points on the circular graph are then plotted in the order in which they are met as one travels along the subhelical curve from the origin. In Figs. 10 and 13 no line has been drawn through these points, but they lie along a curve showing rapid growth in the early part of life, gradually slowing down until growth almost ceases. This is, of course, a reflection of the changing rate of increase of the radius of the subhelical curve in the circular graph.

Considering now the graphs for female *M. subrugosa*, the smallest specimens are seen to have been taken in the period April–May, the curve of error of this group giving a modal value of 6·5 mm. The next point occurs in August–September at 10·0 mm.; but this young group was not sampled in October–November. The point in December–January at almost 11·5 mm. is based on less than 10 per cent of the catch for that period, but lies easily on the curve leading to the point at slightly more than 15·0 mm. in April–May. The female *M. subrugosa* has now completed the first year of post-larval life and the carapace has increased in length from 6·5 to 15·0 mm. The female is now sexually mature and can be found carrying eggs at carapace lengths from 12·0 mm. The onset of sexual maturity probably accounts for the slowing down of the growth rate to a steady increment of about 4·0 mm. each year which now takes place. In the circular graph a slight regression is seen in the third year, from 21·3 mm. in October–November to 21·0 mm. in December–January. Apart from this rather trifling aberration, almost four years of growth can be traced with reasonable accuracy by this method.

The rectangular graph showing growth (Fig. 10) gives a picture of a post-larval life of some six years. During this time the carapace length of the female *M. subrugosa*

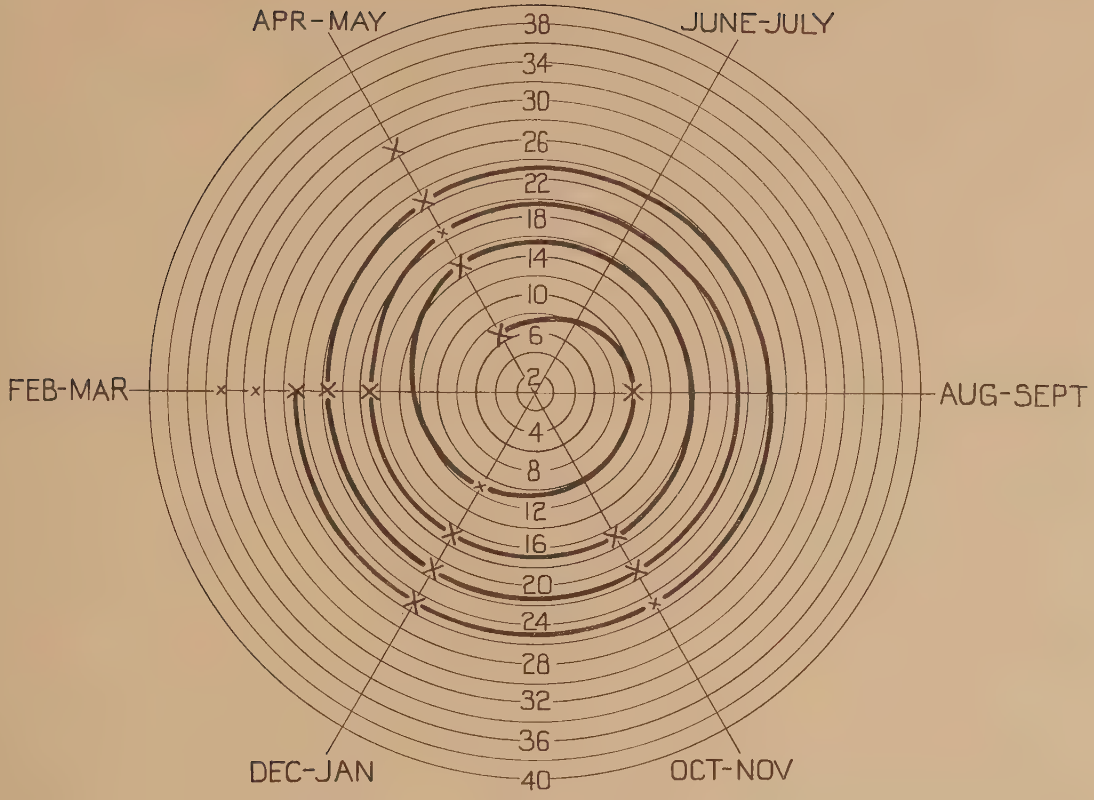

Fig. 9. *Munida subrugosa*, females. Circular graph of modal lengths of curves of error drawn in Fig. 8.

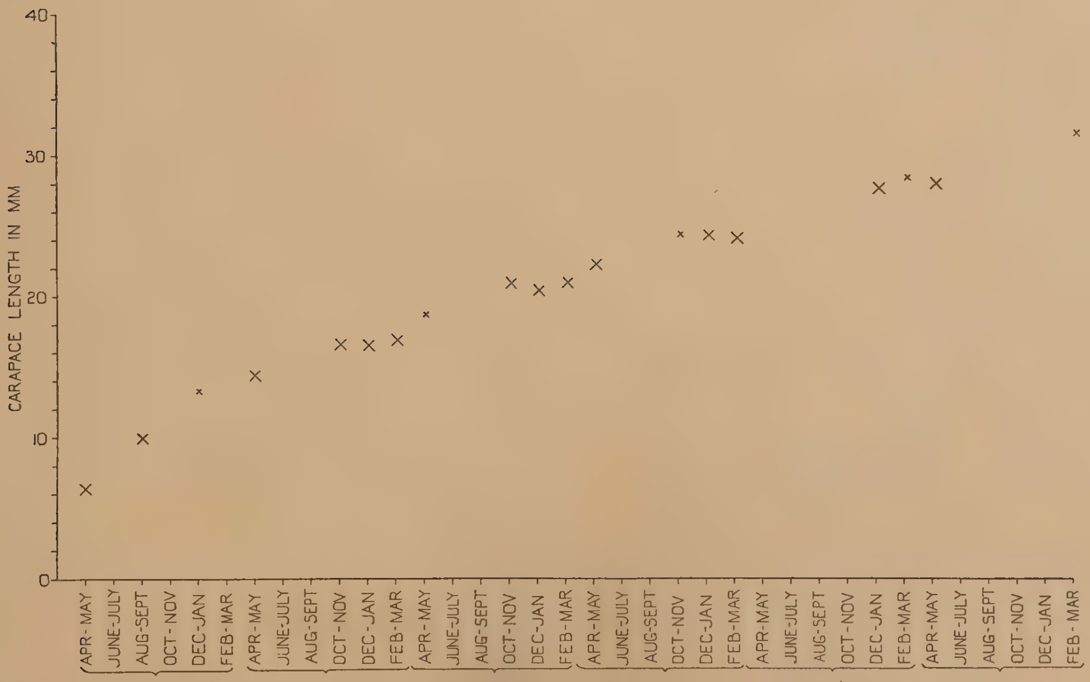

Fig. 10. *Munida subrugosa*, females. Graph of modal lengths of curves of error drawn in Fig. 8.

increases from 6·5 to 32·5 mm. This latter is by no means an extreme length, and it seems not at all unlikely that large specimens may be eight years old or even older.

The curves obtained for the male *M. subrugosa* are closely parallel to those for the female, but they indicate a slower rate of growth especially in the first year. The initial post-larval group in April–May has a slightly smaller modal length of 6·25 mm. The curve in the circular graph (Fig. 12) shows the carapace length at the end of the first year to be almost 12·0 mm., 3·0 mm. less than in the female. The second half of the curve for this year is based upon low figures, less than 10 per cent of the total catch in each period, and one point, that for February–March at 13·5 mm., does not fall on the curve and, it is felt, should be disregarded. Apart from this one point, the subhelical curve can be drawn with reasonable confidence for the first five years of life, and is shown in the figure for the first six. It shows that the male gradually overtakes the female in growth, and the two sexes are roughly of the same length in their sixth year. As in the female, growth continues after this, but the data are altogether too inadequate for discussion. It can, however, be said that the largest specimens taken are usually male, and it seems probable that the male normally lives to a greater age than the female.

MUNIDA GREGARIA

The data which can be used for inquiry into the growth of *M. gregaria* are not of such an extensive or uniform character as those employed for *M. subrugosa*. In the Falkland Islands region this species was not met with during several months of the year and the bulk of the material consists of the immature *Grimothea* stage, the adults seldom being taken in quantity. In view of this it has not been thought advantageous to employ the method used for *M. subrugosa*. The graphs of carapace length for *M. gregaria* (Figs. 14–16) have not been drawn to give each curve of error in its entirety, but they have been drawn with every attention to the form of this curve.

Before considering the curves thus obtained for the specimens taken in the Falkland Islands region an examination of those for the material from New Zealand waters will be helpful.[1] This material, comprising 137 specimens, 69 males and 68 females, was taken in Otago Harbour at intervals varying from five to twelve days during the months November 1932 to March 1933. The collections are well spaced, each month during the period being represented by three or four catches, but the numbers in each catch are small; still, in spite of this, the homogeneity of the whole material gives it a value which is lacking from the more extensive Falkland Islands material. The significance of curves drawn from small samples is discussed by Wollaston (1929) and, accepting his views, it is considered justifiable to draw conclusions even from these small samples. The material was measured in the same manner as the Falkland Islands material, but it has not been grouped into 2 mm. length classes and instead of percentages the actual numbers are shown. Curves have been drawn for each of the five calendar months in which specimens were obtained.

Examining first the curves for the females (Fig. 14, right), a well-defined group is seen

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[1] Procured by the late Mr G. M. Thompson as mentioned in the Introduction, p. 212.

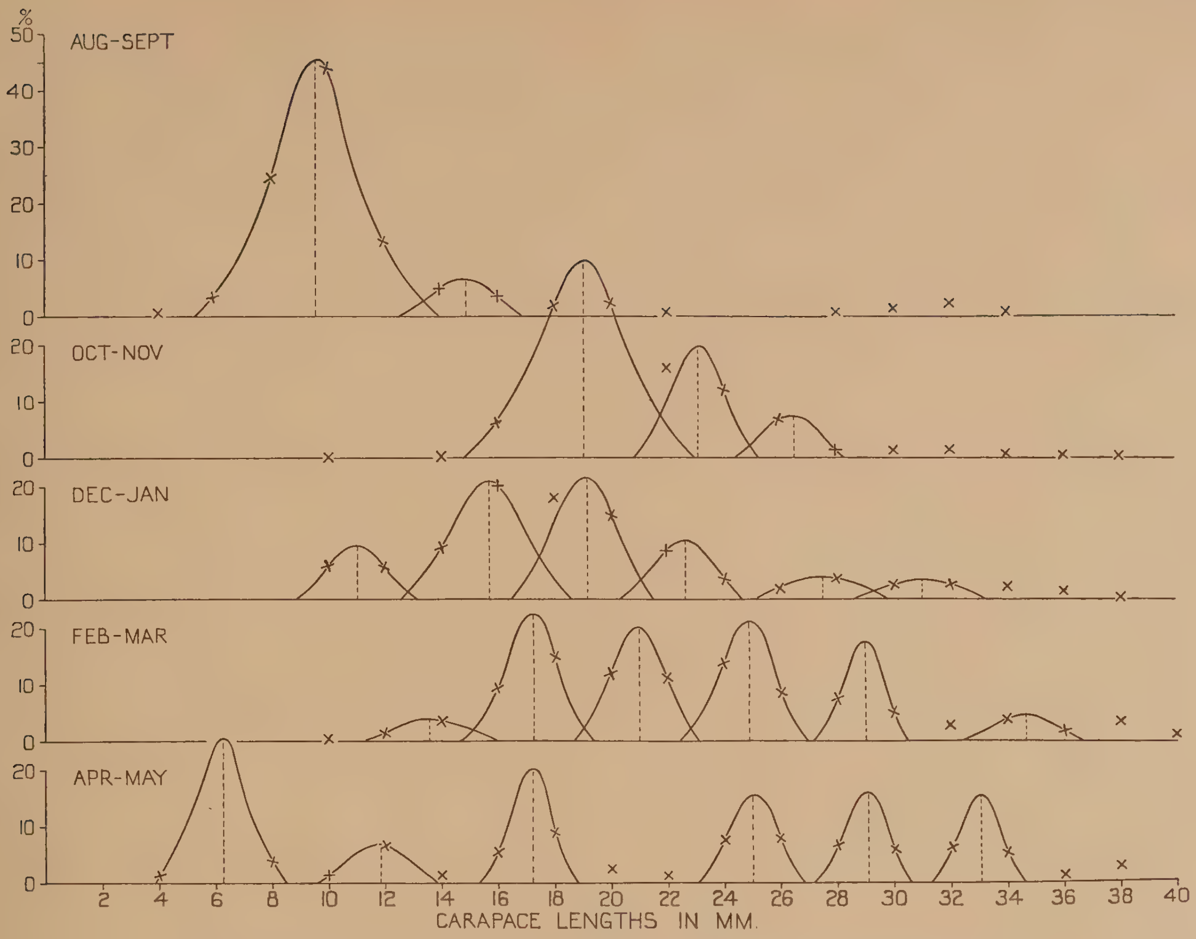

Fig. 11. *Munida subrugosa*, males. Bi-monthly graphs of carapace length frequencies reduced to percentages; each individual "curve of error" drawn in its entirety.

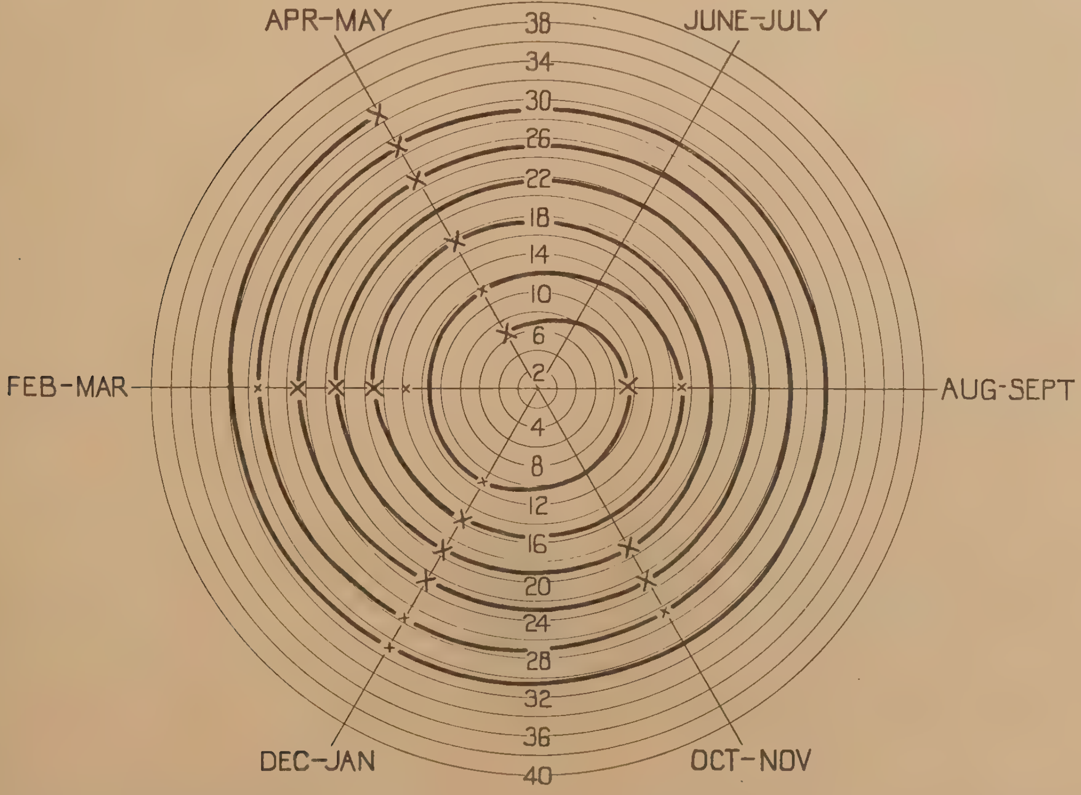

Fig. 12. *Munida subrugosa*, males. Circular graphs of modal lengths of curves of error drawn in Fig. 11.

to be present in November with a modal length of 6·3 mm. The curve for December shows two modes, but this may be due to moulting or to the sampling of a different brood, either a possible cause of this bimodality. A steady increase in modal length to 11·0 mm. in March takes place throughout the series. The curves for the males for November and December show two modes similar to those in the female curve for December and they suggest the same possible causes. The two modes, however, approach and coalesce, so that a maximum growth in the length of the carapace from 6·2 mm. in November to 11·5 mm. in March is shown.

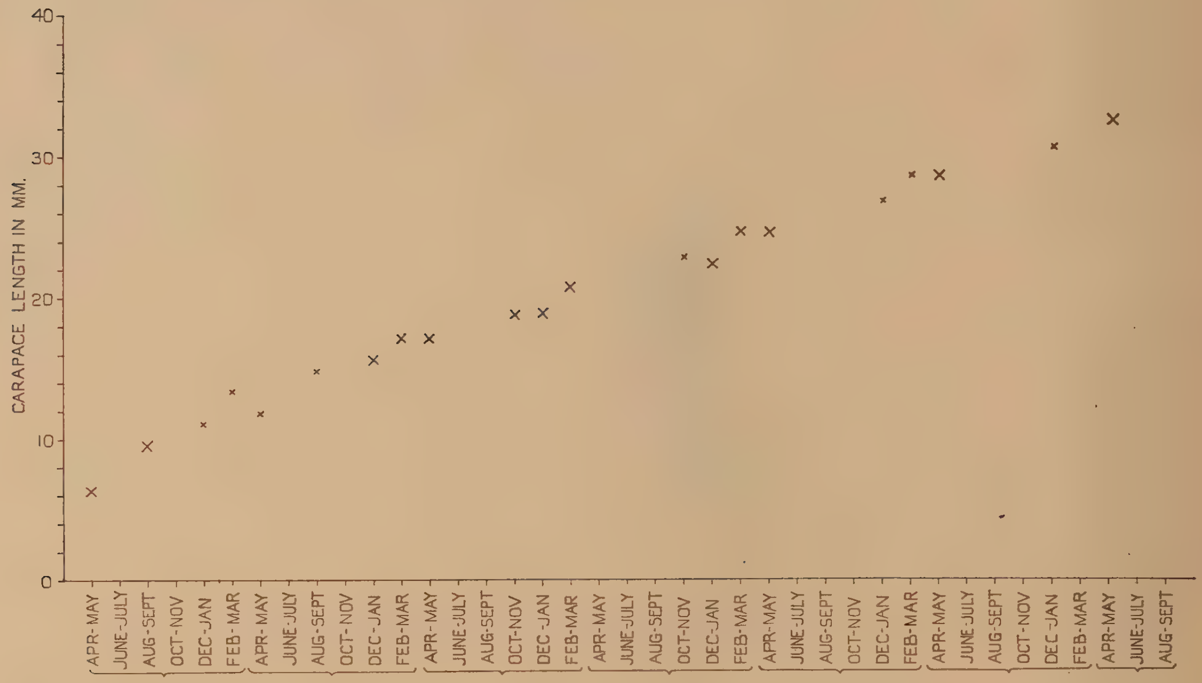

Fig. 13. *Munida subrugosa*, males. Graph of modal lengths of curves of error drawn in Fig. 11.

Turning now to the Falkland Islands material, the female *M. gregaria* makes its appearance at the smallest modal carapace length of 7·0 mm. in January (Fig. 15). The New Zealand specimens of this month have a carapace more than 2 mm. longer, but the difference in latitude of more than 6° between Otago Harbour and the north coastal waters of the Falkland Islands, whence the material was derived, explains the discrepancy. If this smallest group were hatched from the egg in October or November the larval life of this species must be much shorter than that of *M. subrugosa*, which first appear as post-larvae in May and then at a slightly smaller length. February shows this group about a mode of almost 9·0 mm., and by April it has grown to a length of slightly more than 10·0 mm. No increment of importance is added by May. This means a growth of 3·5 mm. in the five months January to May which is rather less than the growth of the New Zealand *M. gregaria* for the five months November to March. This first-year group, in which a considerable retardation of the growth rate is apparent in

April and May, evidently stops growth almost entirely during the winter months, for the mode has not advanced by September.

The April curve shows two other well-defined distributions in addition to that of the first-year group; one with a mode at 21·5 mm. and a second with a mode at 27·5 mm. These are represented in May at 22·0 mm. and 27·5 mm. respectively. For the first-year group of September, with a modal length of 10·5 mm., to reach a modal length of more than 21·0 mm. by the following April means that the length of the carapace would have to be more than doubled in seven months. This does not seem reasonable, and the absence of any records of the second-year group is indicated by the gap shown in the graphs of each month. In December, three individuals at lengths of 13, 14 and 15 mm. respectively are the only representatives of the first-year group after the age of nine months that we have examined. If it be agreed that the second-year group is absent from the material, then the modes in the April curve at 21·5 and 27·5 mm. represent respectively the third- and fourth-year groups. These year groups are indicated in March and well shown in May. In January a mode at a still greater length occurs which will represent the fourth-year group, whilst the two younger year groups were not sampled at all in this month.

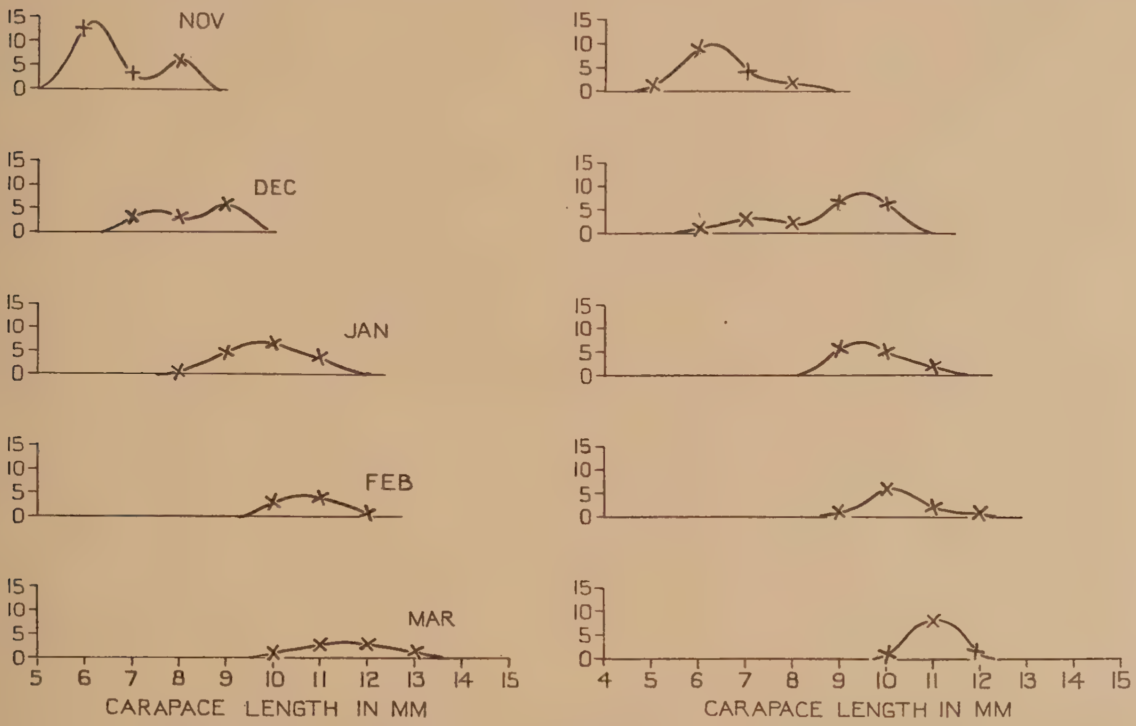

Fig. 14. *Munida gregaria.* Monthly graphs of carapace length frequencies of New Zealand specimens; males on the left, females on the right.

In the male *M. gregaria* the first-year group pursues a similar course to that in the female (Fig. 16). Commencing at the slightly greater modal length of 7·5 mm. in January, it reaches 10·0 mm. by May. An asymmetry on the upper limb of the May

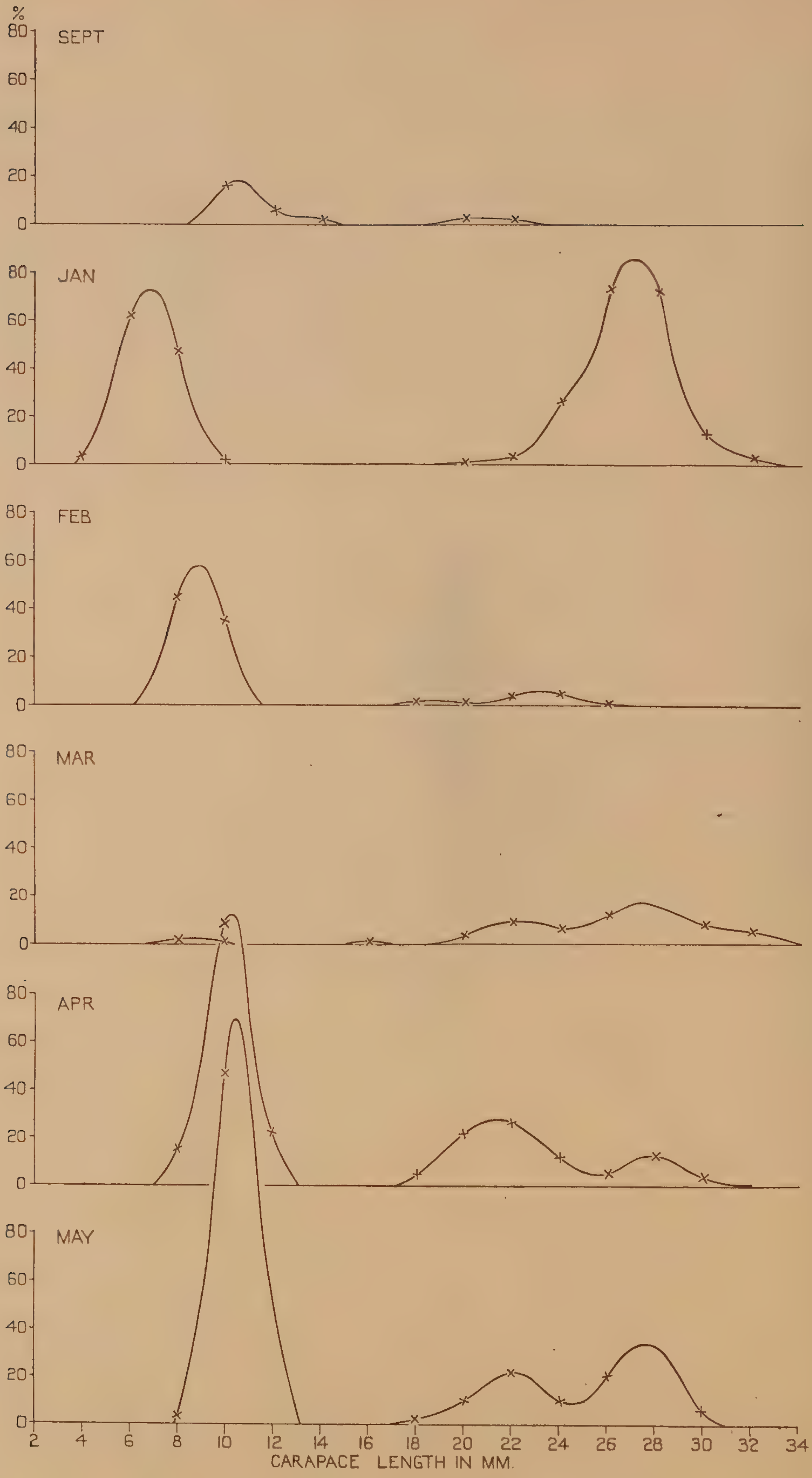

Fig. 15. *Munida gregaria*, females. Monthly graphs of carapace length frequencies of Falkland Islands specimens.

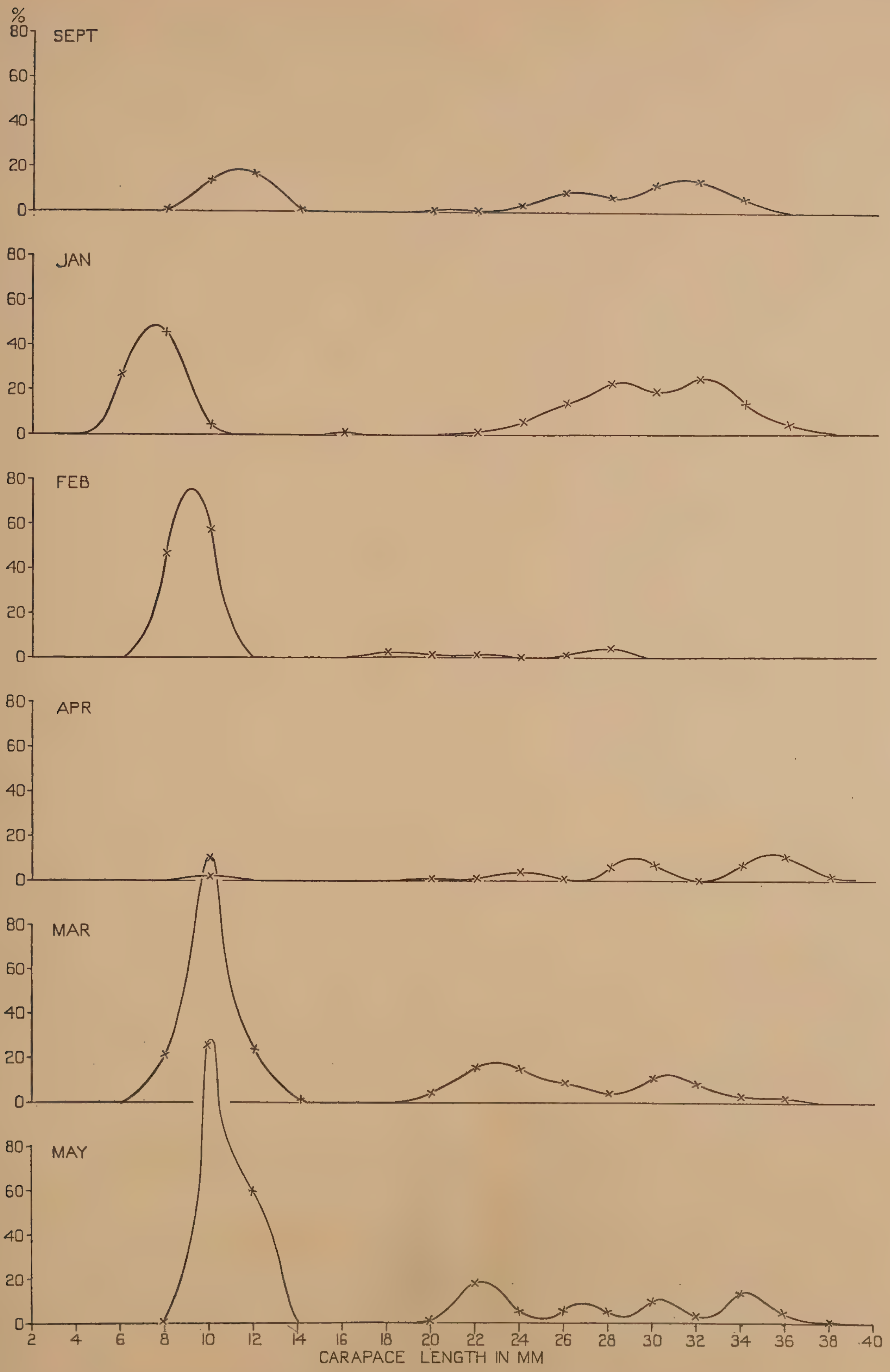

Fig. 16. *Munida gregaria*, males. Monthly graphs of carapace length frequencies of Falkland Islands specimens.

curve of this first-year group probably indicates a moult to the greater length of 11·5 mm. actually in progress. Again, no growth seems to take place during the winter months and the September first-year group is dispersed about a mode slightly above 11·0 mm. corresponding to that indicated in May as an asymmetry on the upper limb of the main curve.

The records of the older groups in the male population are inadequate or absent, and no satisfactory account of the later growth can be deduced from them. The general growth no doubt closely follows that suggested above for the female.

I wish here to acknowledge the help given to me by Mr T. Edser, of the Ministry of Agriculture and Fisheries, whilst preparing this account of the growth of the two species and particularly to thank him for the idea embodied in the circular graphs of Figs. 9 and 12.

EPIZOA AND PARASITES

The two species of *Munida*, in common with many other members of the Decapoda, often carry on their exoskeleton an epizootic fauna. Large and obviously older specimens were those most commonly infected. The commonest epizoa are Serpulid Polychaetes resembling *Spirorbis*. At times these occur very extensively, not only on the carapace, but on the tergites and pleura of the abdominal segments, on the legs, especially on the chelate limb, and even on the ocular peduncle.

M. gregaria was found carrying growth of a Polyzoon, *Alcyonidium* sp. This occurred most frequently on the tergites and pleura of the second to the fourth abdominal segments, where flexion of the abdomen occurs; but on some specimens the incrustations spread over the carapace, on the legs and in one case extend even on to the eyes, obscuring the pigmented corneal portion to such a degree as to interfere with vision. A Vorticellid was seen on the limbs of immature specimens of both *M. gregaria* and *M. subrugosa*.

The two species of *Munida* both harbour a Bopyrid parasite, *Pseudione galacanthae*, Hansen, which takes up its position in the branchial chamber. In all except the most recently infected individuals the presence of the Isopod is displayed by the bulging carapace and branchiostegite, a deformity which in older specimens assumes no mean proportions.

Pseudione galacanthae was first found in *Galacantha diomediae* var. *parvispina*, Faxon, in the Gulf of California (Hansen, 1897). It was recorded from *Munida subrugosa* taken on the east coast of Patagonia by Richardson (1904), and it has also been obtained from *Munida quadrispina*, Benedict. A rather larger size is attained by specimens from the two species of *Munida* considered here than by those first described by Hansen and obtained from *Galacantha diomediae*. The slight asymmetry shown in Hansen's figures of the type is still less marked in the specimens before us. *P. galacanthae* was always found with its head pointing posteriorly with regard to the host and with the long axis of the body lying in a diagonal position so that the anterior part of the body was more ventral in position than the mesosome.

The epicarid larva was obtained from the marsupium of a female. Cryptoniscid larvae were found in the branchial cavity of the *Grimothea* stage of *M. gregaria*; this position had evidently only just been assumed, for the larva was still free and no deformation of the host had yet occurred. These larval stages are very similar in general appearance to the corresponding stages of *Phryxus abdominalis*, Kröyer, as depicted by Sars (1899).

A striking habit of this parasite is the strong preference shown for the right side of the host. This side was usually the one infected, although infection also occurs on the left side only and on both sides. A consideration of all the hauls between September 1931 and March 1932[1] in which infected specimens were obtained, yields the following data:

Munida subrugosa

Total number examined ...	5798		
Number parasitized	429	or 7·4	per cent of the total
Parasitized on right side only ...	395	or 92·1	per cent of those parasitized
Parasitized on left side only ...	20	or 4·6	per cent of those parasitized
Parasitized on both sides ...	14	or 3·3	per cent of those parasitized

Munida gregaria

Total number examined ...	3369		
Number parasitized	125	or 3·7	per cent of the total
Parasitized on right side only ...	114	or 91·2	per cent of those parasitized
Parasitized on left side only ...	10	or 8·0	per cent of those parasitized
Parasitized on both sides ...	1	or 0·8	per cent of those parasitized

The percentage of parasitization in individual hauls varies from zero to 50 per cent in *M. subrugosa* and from zero to 100 per cent in *M. gregaria*.

It would seem that an individual of *M. subrugosa* infected on the left side has almost equal chances of being infected on the right side as well. This is not so for *M. gregaria*, in which, of the total of those parasitized on the left side, 90 per cent are infected only on the left side. The asymmetry of *Pseudione galacanthae* mentioned above is evidently impressed by the shape of the cavity of the carapace in which it lives. Specimens taken from the left side of *M. subrugosa* showed an opposite asymmetry to specimens taken from the right, those from the one side giving the appearance of a mirror image of those from the other. This was especially well seen when the parasites from a host infected on both sides were placed together. Thus no reason for the preference of *Pseudione galacanthae* for one side of its host is to be found in its superficial asymmetry.

One hundred and seventy-one specimens of a large haul of the *Grimothea* stage of *M. gregaria*, not included in the above figures, yielded five infected with the Cryptoniscid larva of *Pseudione galacanthae*. This represents only 2·9 per cent, a figure rather less than the 3·7 per cent obtained from the whole season's data. It may be that infection was only taking place at this juncture and that many more *Grimothea* would shortly be seized upon by Cryptoniscids. Another haul of large *Grimothea* taken later in the year yielded an even lower percentage of infected specimens (1·9 per cent).

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[1] Hauls of the *Grimothea* stage of *M. gregaria* are not included.

There seems to be no evidence that great inconvenience is caused to the host by the presence of the parasite. If a certain proportion of mortality were caused by harbouring the parasite, the percentage of infection in early life should exceed that for the whole population.

DISTRIBUTION

The geographical distributions of *M. subrugosa* and *M. gregaria* have been briefly dealt with by Matthews (1932). He has given their general distribution, so far as it is known, and it remains for us to examine the more detailed distribution in the area covered by the trawling surveys, especially in the light of the large numbers obtained during the period October 1931 to April 1932.

MUNIDA SUBRUGOSA

The area covered by the trawling surveys does not extend beyond the known limits of the occurrence of this species. No station was made either as far north as 35° S, which is given as the northern limit by Matthews, or as far south as Cape Horn where the R.R.S. 'Discovery' took large numbers in 1927. The species is distributed generally over most of this area, but regions of concentration and absence can be mapped. Depth is one of the factors appearing to limit its distribution, and the increasing depth at the edge of the continental shelf forms the eastern boundary. Few hauls of the trawl were made in waters of any great depth, but *M. subrugosa* has been taken at several stations where the haul has commenced or passed into moderate depths from shallower depths, as, for example, at WS 246 and WS 772 where the hauls rose from 267 to 192 m. and 309 to 162 m. respectively. The catches at these stations were always small and the limiting depth was no doubt in the neighbourhood. Only two or three stations of a depth greater than 200 m. and with a level bottom yielded records. It seems evident that *M. subrugosa* is passing beyond its optimum depth when descending below the 200-m. contour. Henderson (1888) records this species at a depth of 600 fathoms off Monte Video; but the record is of a single specimen in a "very imperfect state of preservation", and too much importance should not be attached to it.

Certain areas of the continental shelf show very few, or an absence of, *M. subrugosa* in such a manner as to suggest some definite cause (Fig. 17). The distribution shows a heavier concentration near the coasts, especially off the north and north-west coasts of the Falkland Islands, off north-east Tierra del Fuego, and in the neighbourhood of the mouths of the Rio Gallegos and Rio Coig. Lying outside these two last-named regions comes a long strip, roughly parallel to the coast, of diminished catches and then beyond this an area of absence. Similarly, moving west and north-west from the area of concentration to the north-west of the Falkland Islands an area of scanty numbers is passed through before the same region of absence is reached and records cease. Thus a region, running roughly north and south, in which conditions may be unfavourable to the species, is seen to separate a Patagonian population and a Falkland Islands popula-

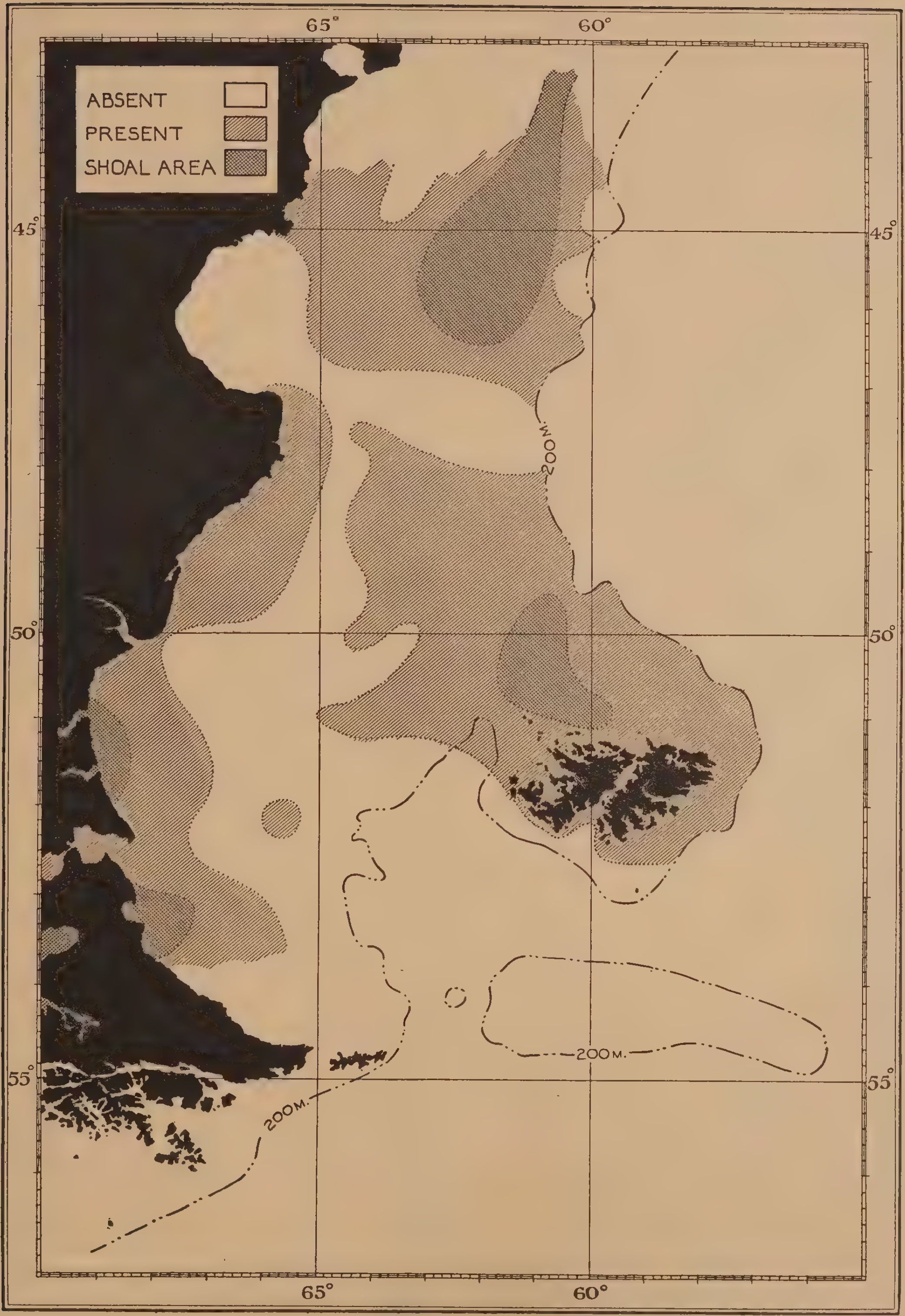
65°
60°
ABSENT
PRESENT
SHOAL AREA
45°
45°
200 M.
50°
50°
200 M.
55°
55°
200 M.
65°
60°

Fig. 17. Chart showing distribution of *Munida subrugosa* in the Falklands area.

tion. South and east of the Falkland Islands group there is an absence of records, but here the continental shelf is narrow and waters of a suitable depth are limited, whilst similarly the depth of the region south-west of these islands precludes the occurrence of this species. Only one station on the Burdwood Bank yields a record, but imperfect exploration of this uncongenial trawling ground makes its distribution here problematic.

In the northern part, the area of the survey is cut across by a zone of absence running east from the Gulf of San Jorge; this zone separates the southern region already described from a northern region of rich abundance where large numbers were taken in each haul of the trawl. West of this rich region can be seen indications of a northward continuation of the longitudinal barren strip running parallel to the coast.

This description of the distribution of *M. subrugosa* is, as stated above, based almost entirely on the results of the 1931–2 survey. The two previous surveys, more restricted in every way, add little to the foregoing conclusions but tend to corroborate them. On the first survey *M. subrugosa* was taken north and north-east of the Falkland Islands and off the Patagonian coast. The central barren area was indicated. The second survey, carried out with especial reference to the edge of the continental shelf, helps to show the influence of depth on the distribution.

The causes of the discontinuous distribution described above have not been ascertained. The areas of concentration or absence appear to have no relationship to the character of the substratum upon which they live. Matthews (1934) has mapped the texture of the bottom deposits obtained on the 1931–2 survey and *M. subrugosa* occurs indiscriminately on all the grades which he distinguishes. The hydrological features of the area are simple and comparatively uniform (Klaehn, 1911). Only the Falkland current has a direct influence in this region, and the only deviation from the simple northward sweep of this water is the small and insignificant counter-current moving southwards along the Patagonian coast. Again, no relationship between the hydrological element in the environment and the above outlined distribution is to be found.

MUNIDA GREGARIA

The distribution of this species is remarkable for its neritic character, and the chart (Fig. 18) shows the manner in which the species surrounds the Falkland Islands and does not occur far from shore. The northern coasts and the entrances to Falkland Sound seem to be favoured localities. Away from the Falkland Islands the species clings close to the coast of Patagonia and Tierra del Fuego. The R.R.S. 'Discovery' took large numbers in the harbours of Hermite Island and Cape Horn, and these records, no doubt, indicate the extreme southern limit.

Occurrences along the Tierra del Fuegian and Patagonian coasts are well marked and doubtless the species is to be found all along this coast, close inshore, until the northern limit is reached. The capture of *M. gregaria* at St. WS 771, 42° 40′ S, 60° 32′ W, is the most northerly record of the species in this region. In addition to the records obtained by the ships of the Discovery Committee, the observations of Captain Fagerli, of the whale factory ship 'Ernesto Tornquist', in the Gulf of San Jorge and southwards from

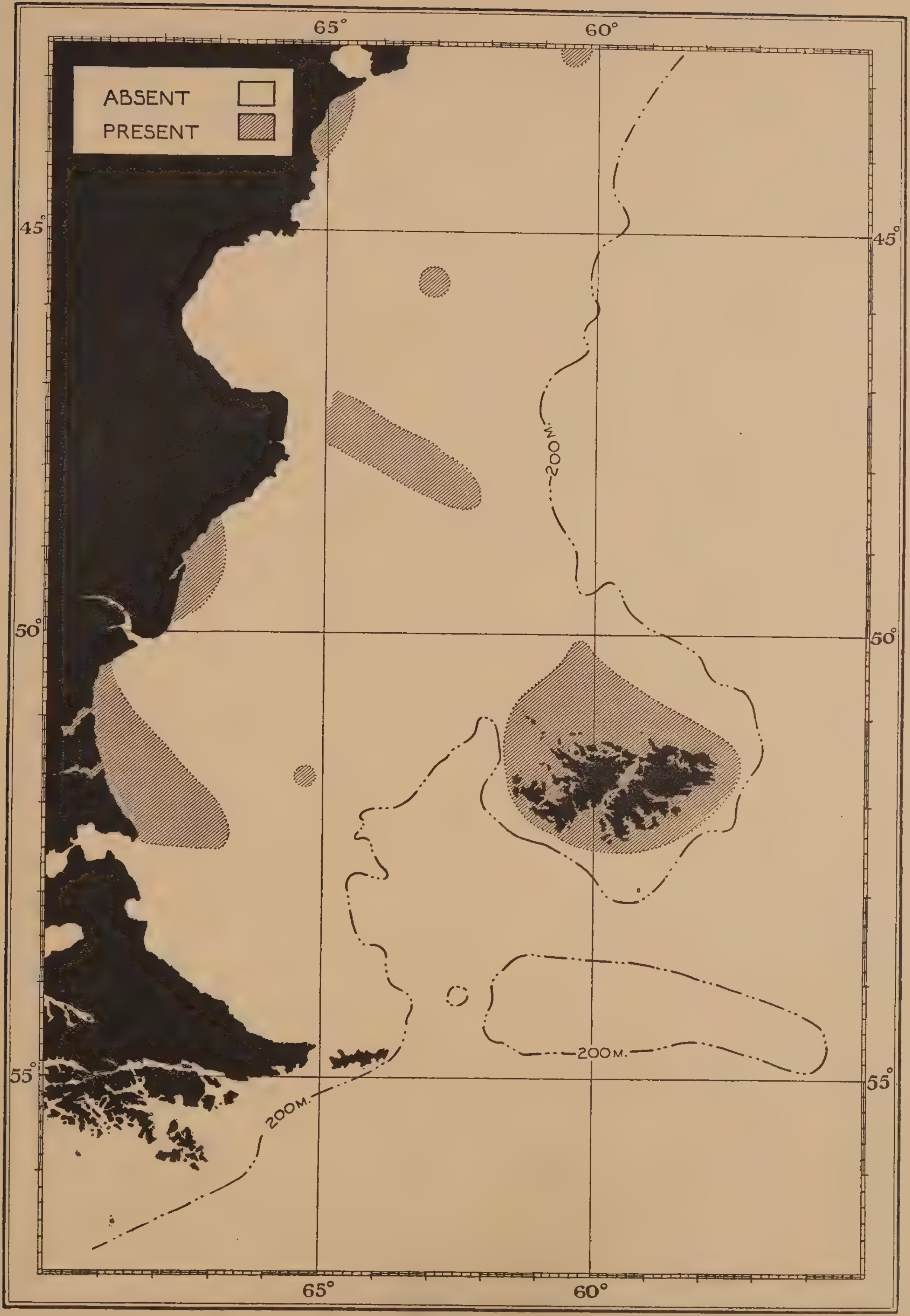
ABSENT
PRESENT
65°
60°
45°
50°
55°
200M.
200M.
200M.

Fig. 18. Chart showing distribution of *Munida gregaria* in the Falklands area.

there, as given by Matthews (1932), must be borne in mind. That *M. gregaria* inhabits the shore waters of the Magellan Straits and the complicated channels of the adjacent regions is well known from the observations of previous expeditions in addition to records obtained by the R.R.S. 'Discovery' and 'William Scoresby'. The only occurrence of note lying offshore[1] is in an area running east-south-east from Cape Blanco. The numbers taken at the stations in this area are few and indicate a very meagre population.

Depth is probably the limiting factor in the distribution of the benthic adult; but it must be borne in mind that the adult stage may lead a pelagic life. Matthews (1932) gives Young's (1925) limit of 60 fathoms (130 m.) as the greatest recorded depth at which the adult is found. Only three or four stations with a greater depth than this have yielded *M. gregaria* in this survey, but considering the habits of the animal it is difficult to know with certainty whether the specimens were actually taken on the bottom or at intermediate depths as the net was on its way to the surface. The greatest possible depth at which adult *M. gregaria* might have been taken was at St. WS 783 with a depth of 159 m.

The *Grimothea* stage of *M. gregaria*, which is discussed in the following section, is usually found in the proximity of land, 60 miles from the Falkland Islands shores at St. WS 100 being the greatest distance out to sea at which it was taken, with the exception of certain records discussed below.

SWARMING OF THE *GRIMOTHEA* STAGE OF *MUNIDA GREGARIA*

Matthews (1932) has discussed the *Grimothea* stage of *M. gregaria* and its relations to the adult at some length. He also remarks upon its swarming habits and quotes from many accounts of old voyages to show how this feature has been remarked upon by the explorers of these regions from the earliest times. Such of these records as can be plotted on the chart show that none occur far from land, but some are placed very much farther north than any of our observations.

On January 30, 1932, the R.R.S. 'William Scoresby' met with many swarms of the *Grimothea* stage over an area some four miles in length, the swarms being so dense as to impart a reddish tinge to the colour of the sea. This area of shoals was situated about ten miles distant from the Eddystone Rock, East Falkland, and close to the position where shoals were encountered by the R.R.S. 'Discovery' on May 4, 1926.

Whilst these shoals were under observation by the R.R.S. 'William Scoresby' Mr E. R. Gunther made the following note: "The patches were either spherical or subcircular suggesting a compact swarm of bees, or were extended into bands of irregular width. One or two feet to three or four feet was the diameter of the smaller patches, but whereas a swarm of bees is very dense and surrounded by wanderers, these swarms had a well defined edge and were less dense". This description is interesting because it was made independently and in complete ignorance of Young's observation on the same phenomenon in New Zealand waters in 1925. His description runs: "The smaller shoals often take a circular shape like a swarm of bees, and the incessant motion of each individual tends to heighten the illusion".

---

[1] In addition there are the following three isolated records; at St. WS 761, two specimens, at St. WS 771 six specimens, at St. WS 791, one specimen.

On February 17, 1932, whilst the R.R.S. 'Discovery II' was lying at anchor in Port Stanley Harbour, a shoal of *Grimothea* came alongside the vessel during darkness and was seen in the water by the light of the gangway cluster lamp which seemed to be an attraction. In the laboratories of the ships the *Grimothea* stage has been observed to display a strong positive heliotropism. The light from a hand torch would cause them to back towards it with remarkable rapidity and precision. On the other hand, on May 23, 1926, specimens were taken in horizontal tow-nets used at depths down to 90 m. at Sts. 66 and 67 which do not corroborate this. St. 66 was made in the dark hours, and specimens were obtained at the surface, at 45 and at 90 m. St. 67 made during daylight hours yielded specimens at 45 and 90 m. On both occasions the largest catches were in the deepest nets. The degree of heliotropism, should any exist, in the pelagic form of *M. gregaria* may vary according to the stage in development, and a specimen positively heliotropic in February might exhibit a very different reaction to light in May.

The swarm of *M. gregaria* from which the specimens obtained at Sts. 66 and 67 were taken was evidently being swept away from suitable and favourable habitats. It was already 300 miles from the nearest land in water of a greater depth than 4000 m. and under the influence of the Falkland current which would continue to carry it to the north-east. It has been shown that *M. gregaria* is a shallow coastal water form, and it would seem that individuals of a swarm such as this, which had been swept away from the adult habitat, would fail in the normal fulfilment of their life history.

LIST OF REFERENCES

ANDERTON, T., 1907. *Observations on New Zealand Fishes made at the Portobello Marine Fish Hatchery.* Trans. Proc. N.Z. Inst., XXXIX, pp. 485, 486.

BENEDICT, J. E., 1903. *Descriptions of a new genus and forty-six new species of Crustaceans of the family Galatheidae, with a list of the known marine species.* Proc. U.S. nat. Mus. XXVI, pp. 244, 308, 314.

BUCHANAN-WOLLASTON, H. J., and HODGSON, W. C., 1929. *A new method of treating Frequency curves in Fishery Statistics, with some results.* J. Cons. int. Explor. Mer, IV, 2, pp. 207–25.

CHILTON, C. 1905. *Note on the function of the last pair of thoracic legs in the Whale Feed* (Grimothea gregaria). Trans. Proc. N.Z. Inst., XXXVII, p. 320.

—— 1909. *Crustacea of the Subantarctic Islands of New Zealand.* The Subantarctic Islands of New Zealand (Wellington), II, pp. 612, 613.

—— 1911. *Scientific Results of the New Zealand Government Trawling Expedition*, 1907. *Crustacea.* Rec. Canterbury [N.Z.] Mus., I, 3, pp. 301–3.

CUNNINGHAM, R. O., 1871. *Notes on the Reptiles, Amphibia, Fishes, Mollusca and Crustacea obtained during the voyage of H.M.S. 'Nassau' in the years* 1866–69. Trans. Linn. Soc. Lond., Zool., XXVII, p. 495.

DANA, J. D., 1852. *Crustacea of the U.S. Exploring Expedition* (Philadelphia), pp. 478, 483, pl. XXX, figs. 7*a–c*, pl. XXXI, figs. 1*a–c*.

GURNEY, R., 1924. *Decapod Larvae.* Reports of the British Antarctic ('Terra Nova') Expedition, 1910, IX, pp. 175, 176.

HAMILTON, J. E., 1934. *The Southern Sea Lion,* Otaria byronia (*de Blainville*). Discovery Rep., VIII, 295, 296.

HANSEN, H. J., 1897. *Reports on dredging operations off the west coast of Central America...by the 'Albatross'...Isopoda.* Bull. Mus. comp. Zool. Harvard, XXXI, p. 118, pl. V, fig. 2.

HENDERSON, J. R., 1888. *Anomura.* Rep. Sci. Results Voyage H.M.S. 'Challenger', Zool., XXVII, p. 124.

HERRICK, F. H., 1895. *The American Lobster. A study of its habits and development.* Bull. U.S. Fish. Comm. XV, pp. 1–252, 54 pls, 38 figs.

HUTTON, F. W., 1878. *On collections from the Auckland and Campbell Islands.* Trans. Proc. N.Z. Inst., XI, p. 340.

KLAEHN, J., 1911. *Ueber die Meeresströmungen zwischen Kap Horn und der La Plata-Mündung.* Ann. Hydrogr. Berl., pp. 647–65, 4 pls.

LEBOUR, M. V., 1930. *The Larvae of the Plymouth Galatheidae.* I. *Munida banffica, Galathea strigosa* and *Galathea dispersa.* J. Mar. biol. Ass. U.K., XVII, pp. 175–87, 3 pls.

LENZ, H., 1902. *Die Crustaceen der Sammlung Plate* (*Decapoda und Stomatopoda*). *Fauna Chilensis.* Zool. Jahrb., Suppl. 5, p. 744.

MATTHEWS, L. H., 1932. *Lobster Krill, Anomuran Crustacea that are the food of Whales.* Discovery Rep., V, pp. 467–84, 1 pl., 1 fig.

—— 1934. *The Marine Deposits of the Patagonian Continental Shelf.* Discovery Rep., IX, pp. 175–206, 13 pls.

MIERS, E. J., 1881. *An Account of the Crustacea collected during the Survey of H.M.S. 'Alert'.* Proc. zool. Soc. Lond., p. 73.

MILNE-EDWARDS, D., 1891. *Crustacea.* Mission Scientifique du Cape Horn, 1882–3, VI, (F), pp. 32–7.

NIERSTRASZ, H. F., und BRENDER À BRANDIS, G. A., 1923. *Die Isopoden der Siboga-Expedition.* II. *Isopoda Genuina.* I. *Epicaridea.* Siboga Expeditie, XXXII*b*, p. 78.

ORTMANN, A. E., 1911. *Crustacea of Southern Patagonia.* Rep. Princeton Exped. Patagonia, 1896–9, III, Zool., 6, pp. 659, 660.

PÉREZ, C., 1927. *Évolution postlarvaire des pléopodes chez les Galathées.* C.R. Acad. Sci., Paris, CLXXXIV, pp. 703–5, 1 fig.

RICHARDSON, H., 1904. *Contributions to the Natural History of the Isopoda.* Proc. U.S. nat. Mus., XXVII, pp. 83, 84.

SARS, G. O., 1890. *Bidrag til Kundskaben om Decapodernes Forvandlinger.* II. Munida. Arch. Math. Naturv., XIII, pp. 132–201, 7 pls.

SARS, G. O., 1899. *An Account of the Crustacea of Norway.* II. *Isopoda.* (Bergen).

SELBIE, C. M., 1914. *The Decapoda Reptantia of the Coasts of Ireland.* Part I. *Palinura, Astacura and Anomura (except Paguridae).* Fisheries, Ireland, Sci. Invest., p. 68, pl. XI, figs. 11, 12.

STEBBING, T. R. R., 1914. *Crustacea from the Falkland Islands collected by Mr Rupert Vallentin.* Part II. Proc. zool. Soc. Lond., pp. 346, 347.

—— 1919. *Crustacea from the Falkland Islands.* Part III. Proc. zool. Soc. Lond., p. 331.

STEPHENSEN, K., 1913. *Report on the Malacostraca Collected by the 'Tjalfe' Expedition,* etc. Vidensk. Medd. naturh. Foren., Kbh., LXIV, pp. 130–4.

THOMSON, G. M., 1899. *A revision of the Crustacea Anomura of New Zealand.* Trans. Proc. N.Z. Inst., XXXI, pp. 193–5.

WAITE, E. R., 1911. *Scientific Results of the New Zealand Government Trawling Expedition,* 1907. *Outcome of the Expedition.* Rec. Canterbury [N.Z.] Mus., I, 3, p. 266.

WEBB, G. E., 1921. *The Larvae of the Decapoda Macrura and Anomura of Plymouth.* J. Mar. biol. Ass. U.K., XII, N.S., p. 398.

WILLIAMSON, H. C., 1915. *Decapoden.* I. Teil (*Larven*). Nord. Plankt., VI, pp. 456–66.

YOUNG, M. W., 1925. *Notes on the habits of Whale-feed* (Munida gregaria). *Marine Biological Notes.* N.Z. J. Sci. Tech., VII, pp. 318–19.

[*Discovery Reports. Vol. X, pp.* 247–282, *Plate XI, June*, 1935.]

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INVESTIGATIONS

ON THE DIATOMS OF THE SKIN FILM OF WHALES, AND THEIR POSSIBLE BEARING ON PROBLEMS OF WHALE MOVEMENTS

By

T. JOHN HART, M.Sc.

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ON THE DIATOMS OF THE SKIN FILM OF WHALES, AND THEIR POSSIBLE BEARING ON PROBLEMS OF WHALE MOVEMENTS

By T. John Hart, M.Sc.

(Plate XI; text-figs. 1–8)

INTRODUCTION

PREVIOUS WORK

The observation that the skins of Southern Blue and Fin whales, within the zone of Antarctic surface water, are sometimes invested with "a yellow slime, apparently due to algae" was first made by the late Major G. E. H. Barrett-Hamilton when working on the whales brought into Leith Harbour, South Georgia, during the season 1913–14 (Hinton, 1925, pp. 110, 137). Later Mr A. G. Bennett independently observed that a similar investment was frequent upon the whales captured on the South Shetland grounds. He also noted that the constituents of the film appeared to be diatoms, and this was fully confirmed by Mr E. W. Nelson in an appendix to Bennett's paper (1920, p. 354). Bennett (p. 353) made the important observation that the whales most heavily infected with diatoms were those which from the thickness of their blubber might reasonably be assumed to have spent some time within the Antarctic Zone; while a majority of the lean individuals, recent arrivals from warmer waters, were noticeably free from diatom film. The resemblance of the colouring on the lighter underparts of the whales to the yellowish bands so common on polar sea-ice at about water-level, which have long been known to be caused by the presence of diatoms, was also noted by Bennett. He concluded that the whales only became infected in Antarctic waters, and that by a study of the diatom species on their skins, and of those upon the sea-ice, it might be possible to gain some insight into the movements of the whales. The first part of this conclusion is undoubtedly correct, but since the predominant diatom of the skin film, *Cocconeis ceticola*, Nelson, is not known from any other habitat, the extent to which the disposition of the skin film can be used as an index to whale movements is strictly limited.

The directions in which Bennett's observations could most usefully be followed up are admirably expressed in Nelson's appendix to the former's paper already quoted, and from the outset of the Discovery investigations, data concerning the skin film of the whales brought in to Grytviken Harbour, South Georgia, have been collected by the officers engaged at the Marine Biological Station. The chief points derived from these data during 1925–7 have been briefly summarized by Mackintosh and Wheeler (1929, pp. 372, 373). They found it impossible to say much concerning the correlation between fatness and diatom infection. Small spots of film were observed on some whales throughout the season. From February onwards thick films covering a large part of the body were sometimes recorded, and conditions are known to be favourable to rapid growth at that time. Immature whales were usually found to be free from film, but patches were found upon them during the later months of the season. The extremely interesting observation that small spots of diatom film occurred on a few immature whales at Saldanha Bay, South Africa, during the winter months of August and September, was also made. The larger mature whales taken at this station were entirely free from infection. This is in good agreement with Bennett's conclusion that the skin film is acquired in Antarctic waters. It may now be considered as well established that a majority of the immature whales lag behind the larger mature whales on their southward migration (Harmer, 1931, pp. 107, 108), and it is therefore almost certain that their return to warmer waters is similarly belated.

Mackintosh and Wheeler noted that early in the season at South Georgia what appeared to be initial stages in the formation of diatom film were frequent. These took the form of small round green patches on the skin an inch or so in diameter. From the conditions observed later it appeared that these were growing colonies which expanded gradually from numerous centres and eventually covered perhaps the whole body within a few months.

In addition to these published works, notes on the diatom film have been made from time to time in the official reports of the officers engaged in the study of whales, which I have been able to consult. Acknowledgments of these sources of information are made in appropriate sections of this paper.

MATERIAL AND METHODS

My own opportunities for direct examination of the skin film were confined to a few visits to the plan at Grytviken, South Georgia, during the 1930–1 season, as I was principally engaged on other work during my stay at the Marine Biological Station. During that season, however, all the scrapings were brought to me for microscopic examination. I have also examined fifty-six scrapings collected by Mr A. H. Laurie on board the S.S. 'Southern Princess', when the vessel was working pelagically in the Indian Ocean sector of the Antarctic during 1932–3. Mr Laurie was working single-handed, so that it was quite impossible for him to make full external examination of all the whales captured. This collection, small as it is, has proved most valuable for comparison with material from the Atlantic sector.

The rest of the material upon which these observations are based consists of notes entered in the whaling logs kept by the Discovery staff for the following seasons and localities:

1928.	January 16–27. Deception Island, South Shetlands ...	29 whales
1928–9.	Grytviken, South Georgia	776 whales
1929–30.	Grytviken, South Georgia	725 whales

The following officers were responsible for the collection of these data:

1928–9. Mr F. C. Fraser, Mr J. W. S. Marr and Mr G. W. Rayner.
1929–30. Dr J. F. G. Wheeler and Dr F. D. Ommanney.

During 1930–1, though able to examine all the scrapings myself, I was almost entirely indebted to Dr F. D. Ommanney and Mr A. H. Laurie for the notes as to the presence or absence and disposition of the film made on the plan. During that season 420 whales were examined.

Apart from the positive evidence furnished by these collections mention should be made of the valuable observation of Dr Ommanney and Mr Laurie that none of the whales examined at Durban during the southern winter of 1930 showed any trace of diatom film.

The extent and disposition of the film, if present, were noted soon after the whale was drawn out of the water, and a scraping taken from it with a knife and preserved in a small labelled tube with formalin sea-water for microscopic examination. Care was exercised that these scrapings were taken from portions of the whale's body that had not been in contact with foreign objects. Occasionally fresh scrapings for immediate observation were also taken.

The examination of the preserved samples was usually completed on the day of their collection. A temporary wet mount was made by pipetting three large drops of the sample on to a clean slide and covering them with a large rectangular cover-glass. This mount was examined for the size and phase of life of the individuals and for the presence of species other than the peculiar skin-film form, for a definite period of time. At first twenty minutes were spent on each sample; later, when a higher degree of proficiency had been attained, this was reduced to twelve minutes. A $\frac{1}{7}$ in. objective was used. This was found better than the more usual $\frac{1}{6}$ in., the slightly higher magnification being of great advantage in the examination of such minute organisms, while at the same time the use of more cumbersome oil-immersion objectives was avoided. A mechanical stage was of course essential.

Samples of unusual interest were retained for further study. Improved methods for the making of permanent mounts of diatoms such as have been devised recently by Ghazzawi (1933, pp. 168–9) were not known at the time, but good mounts were obtained by taking the diatoms up through alcohols into xyol in a hand centrifuge, and mounting in a medium composed of α-bromo-naphthalene and canada balsam, described and recommended for use with diatoms by Edwin E. Jelly in *Nature* (February 22, 1930). Ghazzawi's methods would be highly suitable for making permanent mounts of skin-film diatoms, and may indeed be confidently recommended for use with any strongly silicified forms.

The drawings on Plate XI have all been made to a uniform scale of 1 : 1000. Except for the outlines, the camera lucida was not employed, as the curvature of the valves of the various species of *Cocconeis* is such that it is impossible to focus the whole surface under high magnification. Moreover, the valves are curved in two planes, like cylindrical lenses. Microphotographs are unsatisfactory for the same reason, but were of great assistance in determining the sizes of the frustules.

For demonstrating the actual penetration of the epidermis by diatoms, which occasionally takes place in the vicinity of old scar tissue, sections 10μ and even less in thickness were cut by Mr A. Saunders, the laboratory assistant at Grytviken, and stained with

Delafield's haematoxylin. The diatoms, epidermal and dermal cells take up this stain in very different amounts, so that a good distinction was readily obtained.

The numerical data relating to the whales examined at South Georgia have not been treated statistically, as the numbers in the month groups are scarcely large enough to justify such a procedure. The season's catches have been divided into month groups, and at the end of the season, when whales were getting scarce, the last two months have usually been treated together. This does not lead to so much distortion as might be expected, for whaling rarely continued beyond the second week in April, and in the exceptionally poor 1930–1 season, when the February and March figures were run together, only ten whales were captured during the latter month. In studying the seasonal variation in diatom infection and correlation with fatness, arithmetical percentages and means have been employed. The fatness of a whale has been taken as the blubber thickness on the flank, at the level of the dorsal fin, expressed as a percentage of the length of the whale, measured from the tip of the snout to the notch of the flukes. Thus a whale 23·68 m. long with blubber 10 cm. thick is said to have a fatness of 0·42. This method is that employed by Mackintosh and Wheeler (1929, p. 365). I am indebted to my wife for help in the preparation of the numerical data.

When this work was begun Dr J. F. G. Wheeler, who was in charge of the Marine Biological Station in 1930, gave me the benefit of his experienced advice; he was the discoverer of a new type of film-forming diatom, which has been named in his honour. Thanks are due to Dr F. D. Ommanney, who first observed diatoms actually penetrating the epidermis of whales, for bringing this fact to my notice, and kindly lending me slides and a photograph illustrating the phenomenon. I am greatly indebted to Mr F. W. Mills and Mr E. J. Steer, for systematic references, and to Mr A. Saunders for section cutting and preparing the drawings reproduced in Plate XI. Finally I would like to acknowledge most gratefully the help received from the authorities in charge of the general and cryptogamic sections in the library of the British Museum (Natural History).

THE DISPOSITION OF THE FILM

The film is commonest upon Blue and Fin whales, *Balaenoptera musculus* and *B. physalus*. It is also known to occur more rarely upon the Sei whale, *B. borealis*, the Humpback, *Megaptera nodosa*, and the Sperm whale, *Physeter catodon*. The Sei whale only makes its appearance in Antarctic waters late in the season, so that the reason for the scarcity of film on the specimens examined is obvious. It will be shown subsequently that in all probability quite a large proportion of the Sei whales ultimately become infected, but by that time the whaling season has generally finished. The whalers have a saying "when the Sei whale come, we go"; moreover, Sei whales are never taken when larger and more profitable species are available.

The Sperm whales taken in the far south are all old lone bulls (cf. Hamilton, 1914, p. 22), and these again are rarely captured when other species are available, as their oil cannot be mixed with that of other whales and their subsequent treatment therefore entails much extra labour.

Humpbacks formerly provided the greater part of the season's catch at South Georgia, but of late years their capture has only been permitted by special licence when other species are scarce. Few, therefore, have been examined for the presence of skin film, and, as Bennett (1920, p. 353) has pointed out, the dark colour of these whales naturally renders it extremely difficult to see the diatoms unless present in large quantity.

The Southern Right whale, *Balaena australis*, has long been protected at all shore stations within the Dependencies. During my stay at the shore station one was captured accidentally in thick weather, but Dr Ommanney reports that no trace of diatom film was observed upon it.

There are grounds for believing that diatoms may occur both on the Bottle-nose, *Hyperoödon rostratus*, and the Killer, *Orcinus orca* (Bennett, 1920, p. 353). Mr G. W. Rayner on a whale-marking cruise during 1929 was able to extend Bennett's observation of the probable presence of film on the latter species to the South Georgia area. At 9 a.m. on January 12, from the catcher 'Petrel', to the south of Cooper Island, a large school of Killer whales was observed moving north-west. Many of them passed very close to the ship, and some appeared to be covered with heavy diatom film.

The dolphins, *Lagenorhynchus cruciger* and *Cephalorhynchus commersoni*, which are common round South Georgia, where they are known to the whalers as "springers", are thought to become infected at times, and this may well be so, for Mr Rayner has seen them playing round the larger rorquals as they do round the bows of ships.

Thus it would seem that nearly all the cetaceans found in the seas of the Dependencies are liable to infection with diatom film provided that they remain within the Antarctic Zone for a sufficient length of time.

Almost any part of the surface of a whale may become infected, including even the surface of the flukes, the umbilical and anal regions. It would appear that the diatoms frequently gain their first foothold, as it were, on old scar tissue. This may in part account for the observation, first made by Mackintosh and Wheeler, that the initial stages in the infection take the form of discrete spots and patches, later coalescing to form the continuous sheet of film. When large portions of the body remain uncovered by film, it is nearly always found that if diatoms are present at all they are in the region of the head, on the rostrum and more frequently on the mandible. Occasionally diatoms have been observed to penetrate the epidermis, with a markedly deleterious effect upon it, but a bright yellowish colour, observed rarely and superficially indistinguishable from diatom film, appears to be due to some pathological condition unconnected with the diatoms, which were absent from the scrapings.

THE CONSTITUTION OF THE SKIN FILM

The vast majority of the diatoms forming the skin film belong to the one species *Cocconeis ceticola*, Nelson. In the absence of this species two others, *C. wheeleri*, n.sp., and *Navicula*, sp. ?, have on rare occasions been found to form a film, while several other species were recorded rarely amongst the film of *C. ceticola* during the 1930–1 season. Some were doubtless of accidental occurrence, and it is to be noted that all are recorded as littoral, bottom or ice-forms in Antarctic or sub-Antarctic waters. It is thought, however, for reasons shortly to be discussed, that some of them are definite constituents of the skin film while the whales are alive. Thus the list of diatoms recorded on the skins of whales may be made out as follows:

True constituents of the skin film

Lycmophora lyngbyei, Kützing
Cocconeis ceticola, Nelson
C. imperatrix, A. Schmidt
C. gautieri, H. van Heurck
C. wheeleri, n.sp.
Navicula sp.?
Navicula spp.
Gyrosigma (*Rhoicosigma*) *arcticum*, Cleve

Fortuitous species

Coscinodiscus spiralis, Karsten
Fragilaria antarctica, Castracane
F. striatula, Lyngbye
Navicula grunowi, Rabenhorst
Nitzschia closterium, Ehrenberg

As already stated, the small indeterminate species of *Navicula* and *Cocconeis wheeleri* have been observed to form film without *C. ceticola*, but with regard to the other species thought to be true constituents of the skin film the facts are not so conclusive. All are known as littoral or bottom forms, and most have been observed upon southern sea-ice. They are not very common upon whales, and it might well be argued that their presence is accidental, and that they become attached after the whale's death. Against this view it may be cited that the whales are towed in tail first, which would be expected to wash off the cutaneous investment rather than add to it. Further, the time elapsing between capture and flensing, which was known approximately for over forty whales upon which "other species" were recorded, did not bear any relation to the numbers of these other species present. Taking them individually:

Lycmophora lyngbyei is a very common littoral form growing luxuriantly upon kelp in the Magellan region and at South Georgia, and in the northern hemisphere. Of all littoral forms the tychopelagic habit is perhaps most strongly marked in members of this genus. For this reason alone their presence upon whales would have been regarded as accidental but for the following considerations: they are known to have a remarkable capacity for attaching themselves to objects at a considerable distance from land, and forming colonies in a comparatively short space of time. They have been observed living epizootically on the legs of Copepoda and Mysidacea. Gran (1912, p. 337) gives an instance of the way in which attached forms of littoral diatoms develop on objects in the open sea far from land. Finally, thick growths of *Lycmophora lyngbyei* are common upon the *Coronula* shells at South Georgia, and have been observed to spread on to the surrounding epidermis. Evidently the body of a whale does not form an ideal substratum for this species, but equally evidently it may occur amongst the film of *Cocconeis ceticola* upon living whales.

C. imperatrix and *C. gautieri* have both been observed in the skin film, the former abundantly, the latter rarely. Both are known as littoral and bottom forms in Antarctic waters, and *C. imperatrix* from the Magellan region also. The latter is exceedingly abundant on the kelp round South Georgia and is stated by Earland (1933, p. 30) to be one of the dominant forms in the bottom deposits round the island. Hence it might well be argued that its presence upon the whales was accidental. The following considerations, however, support the view that it may be a true constituent of the skin film. In the first place, of all the littoral forms it is perhaps the least frequent in the inshore plankton, doubtless on account of its heavily silicified frustules; and in the second, while the individuals upon the kelp were very variable in size and in the number of costae, those seen upon whales were markedly uniform in size and invariably had twenty-six costae on either side of the raphe. The endochrome of the individuals seen upon whales was generally pale green in colour, while that of those upon the kelp was yellowish brown. The formation of microspores of this species was observed among the individuals found on whales, but not among those from other habitats. It was frequent upon freshly killed whales, and although known to occur on the kelp near the whaling station no increase in its numbers was ever noted upon whales left lying a long time in the water before flensing, doubtless owing to the almost complete absence of the tychopelagic habit in this species. It would seem, therefore, that in the vicinity of South Georgia *C. imperatrix* may be a true constituent of the skin film.

C. gautieri, first described from bottom samples from the Antarctic Zone, and later recorded from the southern sea-ice, was not observed at South Georgia except upon whales. *C. imperatrix* is also known as an ice form, and here we have a probable source of the infection of South Georgia whales by these two species during the early part of the 1930–1 season. The ice at that time lay unusually far north, and undoubtedly led to a local accumulation of whales, some of which would normally have proceeded farther south, particularly the Blue whales. As shown in Fig. 1 the percentage of whales upon which species other than *C. ceticola* were observed fell steadily throughout the season, and was particularly high during the first month. While it is possible that some of these diatoms, such as *Lycmophora lyngbyei*, were acquired during the whales' southern journey, in littoral south temperate waters, perhaps off the Patagonian coast, the sea-ice appears to be the more probable source of the infection, particularly with regard to *Cocconeis imperatrix* and *C. gautieri*, which are known to occur upon it.

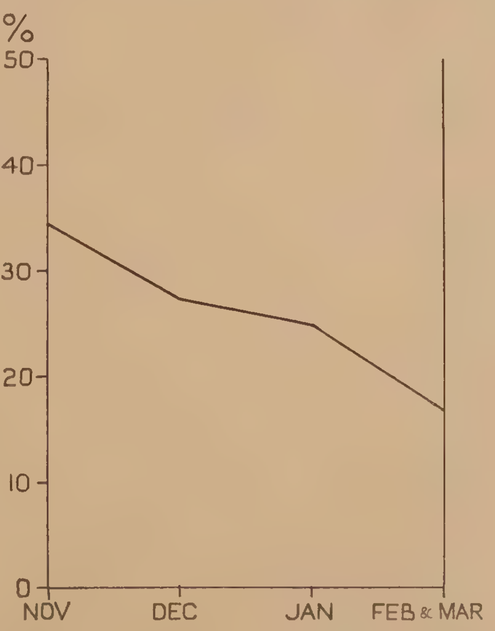

Fig. 1. The monthly variation in the percentage of the total Blue and Fin whales upon which "other species" were observed during 1930–1.

Various minute species of *Navicula* have been observed from time to time in the skin film in numbers such that their occurrence can scarcely be regarded as fortuitous. Their specific identification is a matter of extreme difficulty owing to the chaotic state of the literature on the genus; it has not been attempted here as these species are relatively unimportant members of the skin film.

Perhaps the strongest argument for regarding these "other species", not known from the littoral plankton, as true constituents of the skin film lies in the almost complete absence of oceanic plankton forms occurring accidentally in the film, though they have been noted on the baleen. If appreciable numbers of diatoms become involved in the film while the whale is lying flagged at sea and being towed into harbour tail first, one would expect to find oceanic plankton forms present. South Georgia is a small island, and the characteristically scanty neritic plankton is confined to the bays and a very narrow coastal belt. Offshore a very rich oceanic plankton is to be found during the first half of the season, and as the whales are frequently captured over a hundred miles from land, the force of this argument will be readily apparent. It seems certain that the period while the whales are lying alongside the plan waiting to be flensed is the only time at which contamination is likely to occur. For the reasons previously given, it is extremely improbable that this ever takes place with regard to the species held to be true constituents of the skin film. On the other hand, the species referred to as occurring fortuitously upon whales include the dominant members of the neritic phytoplankton, which very probably gain access to the whales while they are lying waiting to be flensed.

NOTES ON THE SPECIES

Lycmophora lyngbyei, Kütz. This common littoral form, found in both hemispheres, is so well known, and figured in so many works on diatoms, that detailed comment is unnecessary here. An account of its occurrence upon whales at South Georgia has already been given on p. 254. The majority of the frustules found in the skin film appeared to be of the typical proportions described and figured by Lebour (1930, p. 203), but a few specimens with more elongated valves were observed. It was noted that the colour of the endochrome of this species varied from light yellowish green to dark yellowish brown in similar fashion to that of the *Cocconeis ceticola* among which it was found.

Cocconeis ceticola, Nelson (Plate XI, figs. 1–4). The form of the valves of this species has been fully described by Nelson, its founder, in his appendix to Bennett's paper (1920, p. 355). It may be mentioned that in making ordinary mounts of these diatoms it was found to be very difficult to persuade them to lie with their superior valves uppermost. This is apparently due to the lens-shaped character of the frustules shown in Plate XI, fig. 2, in which an attempt has been made to depict the girdle view.

In all the samples examined the vast majority of the individuals were within the size limits laid down by Nelson in his original description of the species. It was noted, however, that there was a strong tendency for most of the diatoms on any given whale to be very similar in size. Accordingly a close watch was kept upon the seasonal variation in size, in the hope that some light might be thrown upon the life history of the diatoms. They were roughly divided into large, medium and small size groups, and the dominant group upon each individual whale recorded. Equal preponderance of two such size groups appeared to be a very rare occurrence, except towards the end of the season, when large- and small-type diatoms occurred in equal numbers on a few whales. As will be seen later, this was probably correlated with extensive microspore formation in February.

Observations on the seasonal variation in size of *C. ceticola* were confined to the 1930–1 season when I was able to examine all the scrapings collected myself. Unfortunately no observations were made in the October of that year, as the shore station party did not arrive at South Georgia until the end of the month. Large- and medium-sized diatoms predominated over small throughout the season. The maximum for the large size was reached in January and for the medium sized a month earlier. There was a very marked increase in the proportion of small diatoms towards the end of the season, with a corresponding decrease of those of the largest size.

The most probable explanation of this size variation becomes apparent when we come to consider the life history of *C. ceticola*. Microspore formation was probably high at the beginning of the season, for as shown in Fig. 2 it was at a minimum in December and January. There was also a very marked increase in microspore formation upon all the classes of whales examined in February and March. These microspores were usually formed in diatoms of the largest size. At first they take the form of small highly refractive spherical bodies with pale green contents arranged round the periphery. Later they appear to take on the characteristic *Cocconeis* shape gradually, giving rise to small-type diatoms. Presumably the larger diatoms are derived from these by auxospore formation, but though ordinary cell division is common I have never been able to detect auxospore formation with any certainty. Auxospore formation is, however, well known in the free-living form *C. placentula* (Hustedt, 1930, pp. 108, 109), a species which resembles *C. ceticola* more closely than any of the other previously known members of the genus. The seasonal variation in the number of instances in which microspore formation was observed, together with certain observations on Sei whales towards the end of the season, enable us to picture the probable way in which *C. ceticola* is disseminated amongst the stock of whales and also furnishes important evidence as to the period of time needed for the film to become established upon whales after their arrival in Antarctic waters.

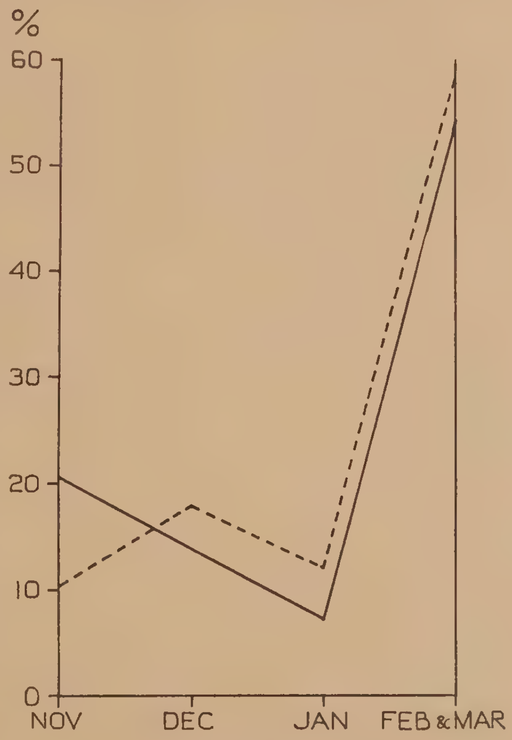

Fig. 2. The seasonal variation in percentage of whales upon which spore formation of *Cocconeis ceticola* was observed at South Georgia in 1930–1. Solid line Fin whales, pecked line Blue whales.

Since *C. ceticola* has not been observed in any of the samples of neritic or ice diatoms so far examined, and as the diatom film is known to disappear when the whales make their way north into warmer waters at the end of the season, it may fairly be concluded, in the present state of our knowledge, that the survival of the diatoms depends on the small residue of the stock of whales that remains in Antarctic waters throughout the winter (Harmer, 1931, pp. 153, 154). How, then, does the film spread so rapidly upon the "clean" arrivals from warmer waters in spring? The development of vast quantities of microspores, which may be shed into the sea, aided by the schooling habit both of the whales themselves and of the food they seek, together with the additional tendency to local concentration caused by the position of South Georgia in relation to the ice-edge and prevailing currents, furnishes the most probable explanation, as we have seen that microspore formation is at a maximum at the beginning and end of the season. The abundance of microspores at the end of the season will tend to ensure that a large proportion of the whales that remain south throughout the winter become infected, and the whole argument is greatly strengthened when the observations on Sei whales during the latter part of the 1930–1 season are considered. As explained elsewhere (p. 261) Sei whales, unlike the larger southern rorquals, make a brief journey southwards towards the end of the whaling season. It is true that they are not captured when a sufficiency of the larger and more profitable species are available, but it so happened that during the second half of the 1930–1 season whales were very scarce, so that it is virtually certain that Sei whales were captured as soon as they appeared on the South Georgia grounds. When they made their first appearance in February no diatom film could be discerned upon them, but skin scrapings from the head region and mandible showed the presence of vast numbers of the characteristic spores of *C. ceticola*, with, in some cases, a few adult frustules. Towards the end of the month one Sei whale was captured with film visible to the naked eye upon the snout. The records from the two previous seasons also suggest that a period of about one month elapses between the entry of the Sei whales into Antarctic waters and the appearance of visible diatom film upon them, for as shown by Deacon (1933, p. 190, fig. 11) South Georgia lies near the northern boundary of the Antarctic Zone.

The colour of the diatoms forming the skin film was found to vary considerably between light yellowish green and dark yellowish brown. A brownish shade has been observed in most living neritic diatoms, many of which are probably saprophytic in their mode of nutrition, while true pelagic forms tend to develop a greener shade. However, pelagic diatoms as seen *en masse* generally appear brownish, it is when the samples are preserved in salt-water formalin that the difference in the quality of the endochrome appears. Under these conditions gatherings of pelagic diatoms always appear green, while gatherings of neritic and skin-film species retain a yellowish tint. The colour of the skin film *in situ* would not appear to give any reliable guide to the mode of nutrition, as Stanbury (1931, p. 651) has observed that diatom cultures show chromatic adaptation to the quality of the light in which they are grown. The quality of the light falling upon the skin film will obviously vary with its position on the whale's body while the latter lies in the water (usually for some hours) before being flensed. This appears to be the obvious explanation of the variation in colour of the skin film observed *in situ*.

While the observation of the difference in colour of similarly preserved samples of skin film and pelagic forms indicates some difference in composition of the endochrome, it is difficult to avoid the conclusion that it is rare for *C. ceticola* to be actively parasitic. The epidermis beneath the film appeared healthy on a large majority of the whales examined. Probably nutrition is partly holophytic, partly saprophytic by utilization of epidermal cells which have died naturally. In rare cases diatoms have been observed to penetrate the epidermis as indicated in Plate XI, fig. 4, when there is no doubt that their presence leads to its rapid disintegration. In all such instances they appear to gain access to the subcutaneous layers through old scar tissue.

A curious feature sometimes observed in fresh samples was the presence of numerous transparent protoplasmic strands, reminiscent of the tangle roots of a bulbous plant, apparently issuing from pores in the superior valves. An attempt has been made to depict these in Plate XI, fig. 2. A similar phenomenon is known to occur in several free-living forms, but it appears probable that these processes may furnish the means by which nutriment can be absorbed saprophytically or even parasitically. In all cases where actual penetration of the epidermis by *C. ceticola* has been observed the diatoms appeared to be fixed to the tissues by their sucker-like inferior valves, while the superior valves with their armature of protoplasmic processes project into the lacunae so formed.

Cocconeis imperatrix, A. Sch. Judging from the remarks of Peragallo (1921, pp. 51, 52) it seems probable that the *C. kerguelensis* of Petit (1889, p. 116, pl. x, fig. 5) and the *C. costata* var. *kerguelensis* of Schmidt should be regarded as varieties of this species. Petit's observations also make it seem probable that the *C. scutellum* var. *ampliata* of Grunow should be included in the synonymy. The considerable range of variation exhibited by *C. imperatrix* is well illustrated by the figures given in Schmidt's Atlas (1890–1902, Taf. 189, figs. 10–15). This variation, especially in size, was noticeable in the littoral forms found at South Georgia, but the individuals found upon whales were very uniform in size, averaging 61 × 55μ and corresponding closely to Schmidt's fig. 15, but with twenty-six pairs of costae. The colour of the endochrome also differed from that of the kelp dwellers, which was yellowish brown, the individuals found upon whales having pale greenish cell contents. The littoral forms showed no trace of microspore formation, but those observed in the skin film frequently contained dark spherical highly refractive bodies thought to be microspores.

Cocconeis gautieri, H.v.H. This is another variable species first recorded by van Heurck (1909, pp. 17, 18, pl. ii, figs. 30, 31 and 33) from a bottom sample obtained in 64° S Peragallo (1921, pp. 52, 53) is of the opinion that it should probably be regarded as synonymous with *C. schuettii*, H.v.H., first recorded in the same bottom sample. *C. gautieri* was not observed at South Georgia except upon whales, and the frustules were always smaller than the type, averaging 49 × 38μ. Peragallo found it to be a common littoral form at the Palmer Archipelago and farther south.

Cocconeis wheeleri, n.sp. This form was first discovered by Dr J. F. G. Wheeler upon a Humpback whale taken at South Georgia during the 1929–30 season, and was observed twice during the following season, in each case upon Humpbacks. It has obvious affinities with *C. ceticola*, Nelson, in the characteristically curved raphe and in the sculpture of the lower valve, but other notable differences appear to justify the foundation of a new species. Chief among these are the much greater width of the girdle (20–30μ) and the very much stronger curvature of the valves. In addition the valves are longer in proportion to their breadth, and altogether larger than the largest known valves of *C. ceticola* (*ca.* 30 × 18μ). The size of the valves of *C. wheeleri* was of the order of 35–42 × 20–22μ, and the girdle was produced into acute projections at the ends of the lower valve. The impression that we are concerned with a species hitherto unknown gathers strength from the fact that this form was observed upon Humpback whales only. A microphotograph of this species is shown in Plate XI, fig. 5, and the points mentioned above are also indicated in fig. 6 and 7. A formal description of this species is as follows:

Cocconeis wheeleri, n.sp. (Plate XI, figs. 5–7)

Raphe, partibus mediis et striis valvae inferioris similibus *C. ceticolae*, Nelson, sed lanceolatioribus, valvis valde arcuatioribus. Mensura valvarum 35–42μ × 20–22μ. Altitudo cesti 20–30μ. Cesto producto in projectiones acutas in extremis valvae inferioris. Hab. in cuti cetorum *Megaptera nodosa*, South Georgia.

When first encountered during the 1930–1 season it was thought that it possibly represented *C. ceticola* in a stage of auxospore formation, but the slightness of the action exerted by solvents upon the girdle, and the large size of the frustules, soon served to dispel this notion.

Navicula sp.? A minute species of *Navicula* characterized by the possession of well-marked central and terminal nodules (Plate XI, fig. 9) was frequently found upon whales. The striation of the valves, if present, was too slight to be made out under ordinary conditions, and accordingly its specific identification has been deferred. In rare instances this diatom occurred in such numbers as to form film in the absence of *C. ceticola*. On one Blue and one Sperm whale it was observed to have penetrated the epidermis, with the result that the latter showed marked signs of deterioration in patches, the main feature of this apparently pathological condition being the development of a brownish colour. Sections across such patches showed the diatoms densely packed along the dermal layer with their long axes at right angles to the surface of the whale's body (Plate XI, fig. 8). Perhaps in correlation with this apparently parasitic habit the endochrome of these diatoms was observed to be of a very pale greenish, almost colourless shade, similar to that of the diatoms found in the baleen.

Navicula spp. Several small species of this genus were met with in the skin film from time to time in numbers such that they were almost certainly present when the whales were alive, but since they formed but an insignificant proportion of the film as a whole, and their identification presents special difficulties, no attempt has been made to name them. It is noteworthy that the colour of the endochrome of these diatoms was comparable to that of the *C. ceticola* among which they were found.

Gyrosigma (Rhoicosigma) arcticum, Cleve (Plate XI, fig. 10). Individuals agreeing closely with Cleve's description (1894–5, Pt. 1, p. 119; Pt. 2, pl. i, figs. 3, 4) of this species were frequently observed upon whales, but not in samples of littoral diatoms at South Georgia. It is, however, almost certain to occur there as a bottom form. The endochrome of the individuals found upon whales was of a markedly brownish tint.

NOTE ON BALEEN DIATOMS

A few scrapings from the baleen of all three species of southern rorquals were examined while working on the skin-film diatoms at South Georgia in 1930–1. Among the film of the protozoan *Haematophagus*, commonly found on the baleen, remains of pelagic diatoms were numerous, but three characteristic species, one of *Cymbella* and two of *Navicula*, constantly occurred undamaged in large numbers, and it would appear from their colourless cell contents that this may indeed prove to be their normal habitat.

AN OUTLINE OF EXISTING KNOWLEDGE OF WHALE MOVEMENTS AT SOUTH GEORGIA

A brief summary of the present state of our knowledge concerning whale movements on the South Georgia grounds is necessary in order to appreciate the possible value of the diatom data. Most of the published work is concerned with Blue and Fin whales, which have furnished the bulk of the catch on these grounds ever since the intensive fishing of Humpbacks ceased. Sei whale, however, provide a most important link in the chain of evidence when the diatom data come to be considered, so that a brief statement of the evidence concerning their migrations may be given before proceeding to the main topic.

Unlike the larger southern rorquals, southern Sei whales appear to pass the greater part of their time in sub-Antarctic and sub-Tropical waters, making a brief journey south late in the season, when the water temperature is at or past its maximum. They very rarely appear on the South Georgia grounds before February and are generally most numerous in March, after which their numbers fall away again even more rapidly (Harmer, 1931, p. 106). This difference in behaviour is probably bound up with differences in feeding habits. While Blue and Fin whales appear to feed very little when in warm or temperate seas, being almost entirely dependent upon the dense shoals of *Euphausia superba* encountered on their southern migration, Sei whales are known to feed extensively on the dense shoals of "lobster-krill" (pelagic post-larval *Munida gregaria*) so common at times off the Patagonian coast (Matthews, 1932, p. 483).

Our knowledge of the movements of the more important Blue and Fin whales may be gathered from three main sources: Mackintosh and Wheeler (1929), in which the work of earlier writers is summarized, Harmer (1931), and Kemp and Bennett (1932).

All authorities seem well agreed that there is in both hemispheres an annual migration polewards in summer for purposes of feeding and to warmer waters in winter for purposes of breeding. When we come to consider the catches on any given whaling ground, such as that off South Georgia, it at once becomes apparent that the course and extent of this migration varies very considerably in the two species, and in different years. The tendency seems to be for whales to arrive in batches, more or less closely aggregated, with one species or sex, or with immature whales predominating. While those of the main stock are doubtless guided in their search for food by complex environmental factors, in the operation of which the spring temperature seems to play an important part (Harmer, 1931, p. 131), the behaviour of immature and lactating whales is somewhat different. This is most probably correlated with their physical inability to respond to the changes influencing their movements with the same speed as the larger or unhampered whales (Mackintosh and Wheeler, 1929, p. 462).

With a cold spring Blue whales are generally more numerous than Fin whales during the first half of the season at South Georgia. With the advent of large-scale pelagic whaling along the ice-edge, it has become well established that the centre of distribution of Blue whales lies to the south of that of the Fin whales, since the greater part of the catch of the pelagic boats is made up of Blue whales. This is in agreement with the observation that Blue whales became relatively scarce on the South Georgia grounds during the later part of the seasons studied for this paper. There is commonly a tremendous influx of immature whales, mainly Fin, assumed to have lagged behind the main southern migration, in January and February.

Kemp and Bennett (1932) have recently made an exhaustive study of whale concentrations and movements on the South Georgia and South Shetland grounds, based on data supplied by the whaling companies. Off South Georgia the general trend of movement appeared to be easterly, with an additional southerly trend in the case of Blue whales. During the first half of the season the data indicated so much northerly movement among Fin whales as to lead the authors to doubt its value. The distributional data clearly indicated that the centre of concentration shifted to the south in January and February, and to the south-east towards the end of the season.

It is obvious that the general idea gained from these more or less direct methods of observation can be usefully supplemented by a consideration of the external parasites of the whales. Thus it seems safe to assume that whales parasitized by *Pennella* and Cirripedia, or bearing the partially healed pits in the blubber observed by Mackintosh and Wheeler (1929, pp. 373, 374), are comparatively recent arrivals from warmer waters. Conversely, as previously shown, the presence of diatom film indicates that the whale has spent some time within Antarctic waters.

Corroborative evidence can also be obtained from the condition of the whales. The increase in proportionate thickness of the blubber during the southern feeding migration, and its rapid decrease in the warmer waters to the north during the southern winter, have been admirably demonstrated by Mackintosh and Wheeler (1929, pp. 368–72).

The impression gained from all these lines of evidence does not appear trustworthy unless comparatively large numbers of whales are considered. It is easy to find individual exceptions to every rule. It is for this reason that in considering the numerical data relating to diatom film the whales examined at South Georgia have been treated in month groups. It was found that such other sources of distortion as were liable to creep in through the use of so large a time unit were for the most part easily detected when working up the detailed records.

SUMMARIZED OBSERVATIONS

A brief summary of the monthly observations at South Georgia, and of the scantier data obtained at the South Shetlands and at the ice edge to the south of Africa, is given in this section. In order to test how far the South Georgia catches departed from the average conditions described in the last section, a very large amount of numerical data has been examined, which has only an indirect bearing on the problem in hand and has therefore been omitted from this paper. The main points revealed by these additional data may be stated first, the detailed monthly figures given later all relate to the actual occurrence of diatoms upon the whales.

Table I

Showing the actual numbers of whales taken at Grytviken, South Georgia, during the months in which skin-film observations were made

	Fin ♂	Fin ♀	Blue ♂	Blue ♀	Sei	Sperm	Hump-back	Totals
Oct. 1928	43	33	5	5	—	2	—	88
Nov.	16	17	21	32	—	1	—	87
Dec.	17	19	32	34	—	—	3	105
Jan. 1929	82	41	44	56	—	1	—	224
Feb.	48	50	3	11	24	—	—	136
March–April	36	45	8	8	36	3	—	136
Total	242	205	113	146	60	7	3	776
Oct. 1929	15	22	10	6	—	—	—	53
Nov.	37	35	12	17	—	—	—	101
Dec.	77	80	9	13	—	—	4	183
Jan. 1930	114	74	14	5	—	3	—	210
Feb.	33	29	—	2	9	4	1	78
March–April	22	31	3	5	33	3	2	99
Total	298	271	48	48	42	10	7	724
Nov. 1930	27	37	40	29	—	1	—	134
Dec.	22	30	39	23	—	—	1	115
Jan. 1931	19	24	16	17	—	1	11	88
Feb.–March	29	19	7	5	19	1	3	83
Total	97	110	102	74	19	3	15	420

From Table I it will be seen that during the seasons studied Fin whales were much more consistent in their occurrence on the South Georgia grounds than Blue whales, and were particularly abundant in 1929–30. Examination of the maturity data for that season, on the criteria laid down by Wheeler (1930), showed that it was a typical "fin-whale year" (cf. Harmer, 1931, pp. 142 *et seq.*). Adult whales predominated early, and a large increase in the proportion of immature whales, that reached a marked maximum in February, was the main feature of the second half of the season. The distribution of Fin whales in 1928–9 followed a similar course, but the increase in proportion of immature whales evidently began earlier, and was more diffuse, though the maximum occurred in the February of that season also. With regard to Fin whales, conditions in 1930–1 were evidently abnormal, an unfortunate circumstance, as it was during this season that the most detailed examination of the diatom film was undertaken. Even in that year, however, there was a marked increase in the proportion of immature whales during the second half of the season, which was, it will be noted, a very poor one from the whalers' point of view. The examination of the maturity data showed that, during the three seasons studied, there was a marked increase in the proportion of immature whales killed as compared with seasons 1924–5 to 1926–7, for which figures were obtained by Mackintosh and Wheeler (1929, p. 468). They found the proportions of immature Fin whales killed to be 22·3 per cent of the males and 27·5 per cent of the females. During seasons 1928–9 to 1930–1 these figures increased to 35·3 and 31·4 per cent respectively, increases of 13 and 3·9 per cent. In the first period the excess of male over female Fin whales captured, 8·46 per cent, was due almost entirely to mature males. In 1928–31 the excess, 4·33 per cent, was due almost entirely to immature males. The percentage of immature whales taken in 1928–9 was particularly high, and can be correlated with the exceptionally low percentage infection with diatom film observed in that season.

The seasonal variation in fatness of the Fin whales was closely studied, and a fair degree of correlation with the diatom data found. Several factors complicate the fatness statistics: excessive fatness of pregnant whales and newly weaned calves, excessive leanness of immature whales and lactating females. These factors appear to cancel each other when large numbers of whales are considered, but when small groups, segregated according to size or sex, are selected, it becomes almost impossible to trace the correlation with diatom film. For this reason the monthly total catch of both sexes has been used, when the correlation agrees very well with the general idea of whale movement gained from other sources. Owing to their small numbers during the later part of the season, the Blue whales do not show this correlation at all clearly.

SOUTH GEORGIA, 1928–9

September and October, 1928

Total whales dealt with 87, of which two were Sperm ♂♂ with diatoms, the rest Blue and Fin whales.

Total Blue and Fin whales ...	86	
With diatoms	40	**47·1 %**
With thick film	11	**12·9**

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	43		33		5		5	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Infected	26	**60·5**	12	**36·4**	—	—	2	**40·0**
With thick film	10	**22·2**	—	—	—	—	1	**20·0**

November, 1928

Total whales dealt with 87, one Sperm ♂ without diatoms, the rest Blue and Fin whales.

Total Blue and Fin whales ...	86	
With diatoms	47	54·7 °/₀
With thick film	14	16·3

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	16		17		21		32	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Infected	10	62·5	11	64·7	11	52·4	15	46·9
With thick film	2	12·5	5	29·4	3	14·3	4	12·5

December, 1928

Total whales dealt with 105, three of which were Humpbacks (2 ♀♀ and 1 ♂) without diatoms, the rest Blue and Fin whales.

Total Blue and Fin whales ...	102	
With diatoms	46	45·1 °/₀
With thick film	14	13·7

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	17		19		32		34	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Infected	8	37·1	6	31·6	16	50·0	16	47·1
With thick film	4	23·5	1	5·3	5	15·6	4	11·8

January, 1929

Total whales dealt with 224, of which one was a Sperm ♂ without diatoms, the rest Blue and Fin whales.

Total Blue and Fin whales ...	223	
With diatoms	114	51·1 °/₀
With thick film	39	17·5

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	82		41		44		56	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Infected	47	57·3	20	48·8	16	36·4	31	55·4
With thick film	19	23·2	8	19·5	8	18·2	4	7·1

February, 1929

Total whales dealt with 136, of which 24 were Sei whales (20 ♀♀ and 4 ♂♂), 1 ♀ with diatoms, the rest Blue and Fin whales.

Total Blue and Fin whales ...	112	
With diatoms	60	53·6 °/₀
With thick film	12	10·7

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	48		50		3		11	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Infected	28	58·3	23	46·0	2	66·7	7	63·6
With thick film	6	12·5	4	8·0	2	66·7	—	—

March and April, 1929

Total whales dealt with 136, of which three were Sperm ♂♂ (with diatoms) and 36 Sei whales. Of the Sei whales six were ♂♂ and 30 ♀, three of the ♀♀ showing diatom film. All the rest were Blue and Fin whales.

Total Blue and Fin whales ...	97	
With diatoms	71	73·2 °/₀
With thick film	20	20·6

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	36		45		8		8	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Infected	27	75·0	32	71·1	7	87·5	5	62·5
With thick film	8	22·2	5	11·1	3	37·5	4	50·0

SOUTH GEORGIA, 1929–30

October, 1929

Total whales dealt with 53, all being Blue or Fin whales.

Total Blue and Fin whales ...	53	
With diatoms	34	64·2 °/₀
With thick film	16	30·2

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	15		22		10		6	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Infected	11	73·3	13	59·1	7	70·0	3	50·0
With thick film	5	33·3	6	27·3	3	30·0	2	33·3

November, 1929

Total whales dealt with 101, all being Blue or Fin whales.

Total Blue and Fin whales ...	101	
With diatoms	63	**62·4** °/₀
With thick film	17	**16·8**

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	37		35		12		17	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Infected	30	**81·1**	19	**54·3**	6	**50·0**	8	**47·1**
With thick film	8	**21·6**	5	**14·3**	3	**25·0**	1	**5·9**

December, 1929

Total whales dealt with 183, of which four were Humpbacks (3 ♂♂ and 1 ♀), 1 ♂ with diatoms, all the rest Blue and Fin whales.

Total Blue and Fin whales ...	179	
With diatoms	125	**69·8** °/₀
With thick film	45	**25·7**

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	77		80		9		13	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Infected	55	**71·4**	60	**75·0**	5	**55·6**	5	**38·5**
With thick film	19	**24·7**	22	**27·5**	3	**33·3**	1	**7·5**

January, 1930

Total whales dealt with 212, of which one was found dead and another so rotten that it was impossible to say whether diatoms were present or not. Three Sperm ♂♂, all without diatoms, all the rest Blue and Fin whales.

Total Blue and Fin whales ...	207	
With diatoms	113	**54·6** °/₀
With thick film	47	**22·7**

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	114		74		14		5	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Infected	72	**63·2**	32	**43·2**	8	**57·1**	1	**20·0**
With thick film	30	**26·3**	14	**18·9**	2	**14·3**	1	**20·0**

February, 1930

Total whales dealt with 78. Of these one was a Humpback ♀, nine were Sei (1 ♂, 8 ♀♀) and two were Blue ♀♀, all without diatoms, and four Sperm ♂♂, two of which had spots of film on the flanks. Fin whales only tabulated.

	Fin ♂		Fin ♀		Total	
Nos. of whales ...	33		29		62	
	Nos.	%	Nos.	%	Nos.	%
Infected	26	78·8	16	61·5	42	67·7
With thick film	13	39·4	5	17·2	18	29·0

March and April, 1930

Total whales dealt with 98, of which 53 were Fin whales, the rest a very mixed catch as shown below:

Sp. sex	No. infected	No. with thick film	Total number
Sei ♂	1	—	18
Sei ♀	2	—	15
Blue ♂	1	—	2
Blue ♀	3	2	5
Humpback ♂	—	—	1
Humpback ♀	1 (*C. wheeleri*)	1	1
Sperm ♂	—	—	3

	Fin ♂		Fin ♀		Total Fin whales	
Nos. of whales ...	22		31		53	
	Nos.	%	Nos.	%	Nos.	%
Infected	16	72·7	19	61·3	35	66·0
With thick film	12	54·5	12	38·7	24	45·3

SOUTH GEORGIA, 1930–1

November, 1930

Total whales dealt with 134, of which one was a Sperm ♂ without diatoms, and the rest Blue and Fin whales.

Total Blue and Fin whales ...	133	
With diatoms	84	63·2 %
With thick film	37	27·8
With "other species" ...	46	34·6
With spores	20	15·0

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	27		37		40		29	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
With diatom film	21	77·8	27	73·0	24	60·0	12	41·4
With thick film	11	40·7	12	32·4	10	25·0	4	13·8
With "other species"	6	22·2	18	48·6	18	45·0	4	13·8
With spores	6	22·2	7	18·9	5	12·5	2	6·9

Mean frequency per cent of "other species", all Blue and Fin whales:

Cocconeis imperatrix	17·2	*Gyrosigma arcticum*	9·0
Navicula sp.?	19·5	*Lycmophora lyngbyei*	11·3

December, 1930

Total whales dealt with 115, of these one was a Humpback ♀, and the rest Blue and Fin whales.

Total Blue and Fin whales ...	114	
With diatoms	84	73·7 %
With thick film	30	26·3
With "other species" ...	31	27·2
With spores	18	15·8

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	22		30		39		23	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
With diatom film	20	90·9	22	73·3	25	64·1	17	73·9
With thick film	9	40·9	6	20·0	9	23·1	6	26·1
With "other species"	2	9·1	9	30·0	15	38·5	5	21·7
With spores	2	9·1	5	16·7	7	17·9	4	17·4

Mean frequency per cent of "other species", all Blue and Fin whales:

Cocconeis imperatrix	13·2	*Gyrosigma arcticum*	4·4
Navicula sp.?	12·3	*Lycmophora lyngbyei*	8·8

January, 1931

The total number of whales taken was 91, and of these 89 were examined externally. Of these 11 were Humpbacks, one was a Southern Right whale and one a Sperm ♂. Six of the Humpbacks were ♀♀ and 5 ♂♂; one ♀ bore a film with normal *Cocconeis ceticola*, and another a film composed of *C. wheeleri*; on 5 ♀♀ and 3 ♂♂ *Lycmophora lyngbyei* grew thickly on *Coronula* shells. The large Sperm ♂ was infected with *Navicula* sp.? and in places with *Cocconeis ceticola* also (of slightly abnormal proportions); another *Navicula* sp. was also present: spots apparently representing recent infection showed spores and small-type frustules of *C. ceticola*, and an apparently pathological condition of the epidermis. No skin diatoms were seen on the Southern Right whale.

Total Blue and Fin whales ...	76	
With diatoms	58	76·3 %
With thick film	25	32·9
With "other species" ...	19	25·0
With spores	7	9·2

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	19		24		16		17	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
With diatoms	18	94·7	17	70·8	10	62·5	13	76·5
With thick film	12	63·2	6	25·0	3	18·8	4	23·5
With "other species"	4	21·0	3	12·5	4	25·0	8	47·1
With spores	2	10·5	1	4·2	3	18·8	1	5·9

Mean frequency per cent of "other species", all Blue and Fin whales:

Cocconeis imperatrix	10·5	*Gyrosigma arcticum*	3·9
Navicula sp.?	10·5	*Lycmophora lyngbyei*	11·8

February and March, 1931

During this period 84 whales were taken, and 83 examined externally. Of these 19 were Sei whales, three Humpbacks, and one a Sperm ♂. The remaining 60 were all Blue and Fin whales.

Of the 19 Sei whales, seven were ♂♂ and 12 ♀♀. Diatoms were visible to the naked eye on 1 ♀ only, on the snout. Microscopic examination showed immense numbers of developing spores of *Cocconeis ceticola*, with few adult frustules, and odd individuals of *Navicula* sp.? and *Lycmophora lyngbyei*. On 12 other Sei whales examination showed that diatoms or their spores (on 6 ♀♀ and 1 ♂ in very large numbers) were present. The spores were clearly recognizable as those of *Cocconeis ceticola*, and in all but four cases a few adult frustules of that species were also present.

Upon a Humpback ♀ film composed of *C. wheeleri* was present, and on the Sperm ♂ developing spores and a few adult frustules of *C. ceticola*, and also *Navicula* sp.? were found.

Total Blue and Fin whales ...	60	
With diatoms	51	85·0 %
With thick film	23	38·3
With "other species" ...	10	16·7
With spores	33	55·0

	Fin ♂		Fin ♀		Blue ♂		Blue ♀	
Nos. of whales ...	29		19		7		5	
	Nos.	%	Nos.	%	Nos.	%	Nos.	%
With diatoms	27	93·1	13	68·4	6	85·7	5	100·0
With thick film	14	48·3	7	36·8	—	—	2	40·0
With "other species"	3	10·7	3	15·8	4	57·1	—	—
With spores	19	65·5	7	36·8	5	71·4	2	40·0

Mean frequency per cent of "other species", all Blue and Fin whales:

Cocconeis imperatrix	3·3	*Gyrosigma arcticum*	1·7
Navicula sp.?	6·7	*Lycmophora lyngbyei*	3·3

SOUTH SHETLANDS, JANUARY, 1928

During this month a few observations were made by Mr Fraser and his colleagues, while awaiting transport to South Georgia, on whales brought to Deception Island. The presence or absence of diatoms was noted upon 24 Fin whales and three Blue whales. Diatoms were recorded on 18 whales and thick or extensive film on 11. Thus the percentage infection was 66·7, and the percentage with thick film 40·7. The numbers are obviously too small to warrant any more detailed treatment.

ICE-EDGE TO THE SOUTH OF AFRICA, 1932–3

Mr Laurie was able to collect some fifty scrapings during this season in the S.S. 'Southern Princess', but as this represented only a small fraction of the catch, no attempt has been made to work out the seasonal variation in percentage infection. Nevertheless this collection indicated a steady increase in infection throughout the season, as would be expected from the more detailed work in other areas. It was very interesting to find the Blue whales far to the south of the African Continent infected by the identical diatom species, *Cocconeis ceticola*, so common in the Falklands sector of the Antarctic. The individual frustules appeared to be slightly larger, on an average, and very slightly narrower in proportion to their length. In all other respects no difference could be detected. All but one of these samples were obtained from Blue whales. Spore formation was commoner than at South Georgia, particularly at the beginning and end of the season. A feature of great interest was the occurrence in a majority of the scrapings of large numbers of the ciliate protozoan described and figured by Mackintosh and Wheeler (1929, p. 377). Later observations by Dr Wheeler led him to believe that the presence of this ciliate on the South Georgian whales was probably accidental, as he found it living in the water round the whaling station. Mr Laurie's collection seems to indicate that it may be a common external parasite of whales, for the 'Southern Princess' was working in the open ocean many miles from land. In some of the scrapings ciliates which had apparently ingested some of the diatoms were found.

THE SEASONAL VARIATION IN PERCENTAGE INFECTION

From the monthly observations summarized in the last section, it became clear that a considerable difference in the percentage infection of the two sexes of Blue and Fin whales occurred. In the sixteen month groups studied the percentage infection of Fin males exceeded that of Fin females on all but two occasions—in November 1928 and December 1929. The figures for Blue whales are not so reliable owing to the greater fluctuations in the catch of this species at South Georgia. Out of fourteen month groups the percentage infection of Blue males exceeded that of Blue females on nine occasions, but on four of these the excess was slight. The conclusion reached is that while the behaviour of the two sexes in the Fin whale must differ considerably on the South Georgian grounds, that of the Blue whales is more uniform. A majority of the Blue whales are probably on passage to and from other feeding grounds farther south, and a large proportion of the Fin whales taken during the second half of the season are immature. The evidence of the skin-diatom infection suggests that the schooling habit is strongly developed among the immature males.

Considering the seasonal variation in percentage infection of the two species it is at once apparent that diatoms are more common on Fin whales than on Blue, except at the end of the season when the Blue whales captured are almost certainly on their way north.

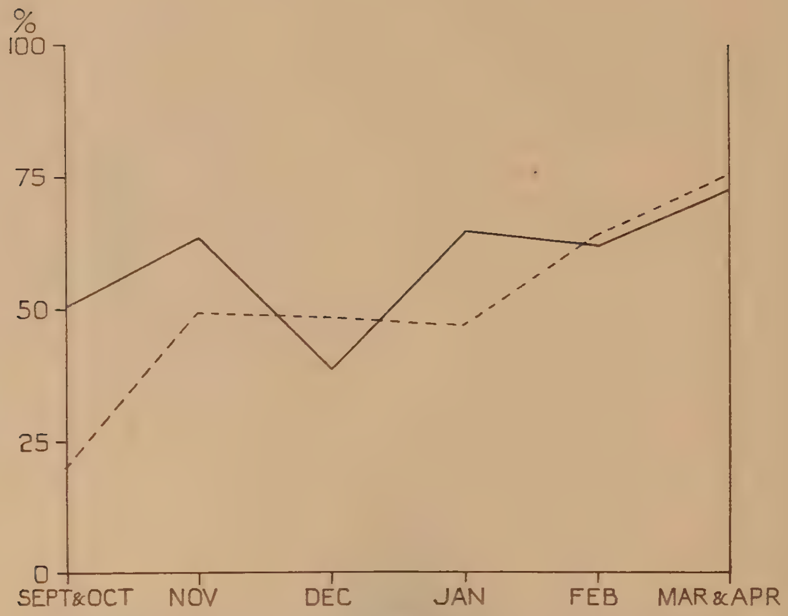

Fig. 3. Seasonal variation in percentage infection at South Georgia during the 1928–9 season. Solid line Fin whales, pecked line Blue whales.

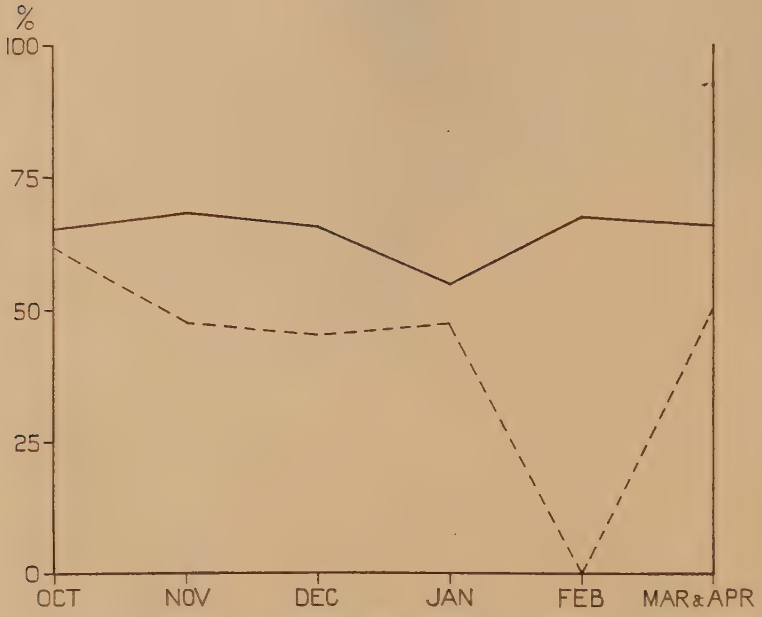

Fig. 4. Seasonal variation in percentage infection at South Georgia during the 1929–30 season. Solid line Fin whales, pecked line Blue whales.

This is clearly shown by the figures for 1928–9 (Fig. 3). The marked falling off in percentage infection of Fin whales in December represents the second wave of invasion from the north. Examination of the maturity data for this season showed that an unusually large number of the December arrivals were mature, while it is evident from the diatom data that some of the later immature arrivals had been within the Antarctic Zone for some time. Kemp and Bennett's observations (1932, p. 180) make it seem most probable that these infected immature whales were approaching from the westward. In all other respects, the diatom data for this season is in accordance with the general idea of whale movements gained from other sources.

The figures for the following season (Fig. 4) do not agree so well. Little reliance can be placed on the Blue whale figures for the later part of this season as the numbers taken were very small. It is probable, however, that a majority of the Blue whales taken at South Georgia throughout that season were recent arrivals in the Antarctic Zone on passage to more southerly feeding grounds, and that but few of them followed the same route on their return. The initial percentage infection of both species during this season was high, which indicates that an unusually large nucleus of the stock remained south during the preceding winter. This is well borne out by a study of the percentage having thick or extensive film, figured in the next section (Fig. 6). The influx of immature Fin whales after the new year is reflected in the drop in percentage infection during January 1930.

The figures for the third season studied, 1930–1 (Fig. 5), are somewhat vitiated by the absence of observations in October, but suffice to show that conditions must have been somewhat abnormal. The Blue whale figures follow a more or less normal course, with an extremely high percentage infection at the end of the season, when they were presumably travelling north. The Fin whale figures were extremely high throughout, and such immature whales as arrived after mid-season had evidently passed some time within the Antarctic Zone, as most of them were infected. These conditions again were probably brought about by an unusually large number of whales remaining south throughout the winter. The latter part of the preceding season had been unusually mild, with poor plankton. In the spring of 1930–1 the pack-ice extended to the north of South Georgia and almost certainly caused the whales to accumulate locally, which would in itself favour rapid infection. Then, after the ice cleared away, it is at least possible that, owing to previous lack of food, persecution,

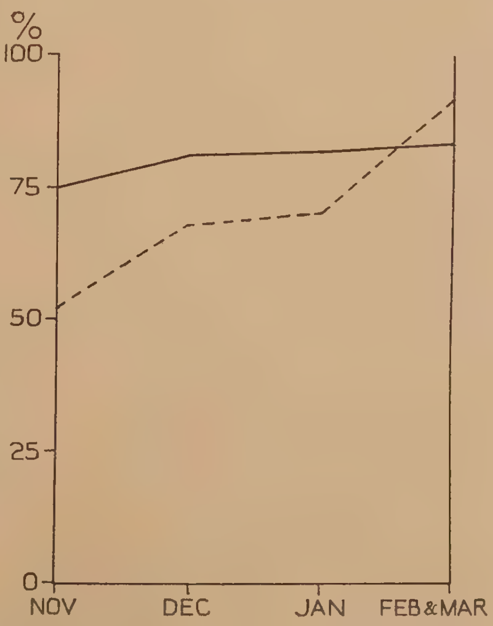

Fig. 5. Seasonal variation in percentage infection at South Georgia during the 1930–1 season. Solid line Fin whales, pecked line Blue whales.

or other causes, the stock that would normally have invaded South Georgian waters from the north followed some other route, and were replaced by a small number of whales moving in a west to east direction.

The general agreement between the seasonal variation in the stock of Fin whales at South Georgia and the inferences that can be drawn from diatom infection receives striking, if unconscious, confirmation by some of the earliest observers. Captain Bryde and Mr Henriksen, in 1913, informed Major Barrett-Hamilton of the existence of "separate schools that do not mix, of a larger grey or *yellowish*[1] form, and a smaller black form, of South Georgian Finners" (Hinton, 1925, p. 129). Since the large whales tend to arrive on the grounds early, they are naturally more liable to diatom infection than the smaller whales, mainly immature, which are known to arrive in well-segregated schools about mid-season. The yellowish colour produced by diatoms can be so marked as to have led in the past to the mistaken recognition of the "sulphur-bottom" as a distinct species, so that considered in this light the observation becomes readily understandable.

The fairly good agreement between the percentage infection and the general knowledge of whale movements gained from other sources indicates that it is a useful aid to the study of migration, provided that a sufficiently large number of observations are available. By itself the method would be unreliable except in so far as it seems certain that an infected whale has passed at least a month within the Antarctic Zone.

THE SEASONAL VARIATION WITH THICK FILM

The percentage of Blue and Fin whales upon which thick and extensive film was observed during the three seasons studied is shown in Fig. 6. It will be seen that the figures bear out the impressions gained from the study of percentage infection, some features, indeed, being very strongly accentuated. Chief among these are the large number of whales that must have been a long time in Antarctic waters and yet were captured at the beginning of the 1929–30 and 1930–1 seasons, and the return of Blue whales to South Georgia from more southerly waters in March and April 1929. During the 1928–9 season the influx of Fin whales in December is clearly shown by the low proportion with thick film; the February figures were similarly low, though, as we have seen, the percentage infection showed but a slight falling off. Thus the impression is gained that while the influx of immature whales in February cannot have come directly from the north, a majority of them had not been very long within the Antarctic Zone.

The steady increase in the percentage of Fin whales with thick film during the latter half of the 1929–30 season indicates that the whales were remaining on the grounds, as the percentage infection never became very high owing to the arrival of immature whales from the north.

The figures for the abnormal 1930–1 season indicate that some Fin whales moved south during December, and since all the figures are high they support the view that the whales were concentrated to an unusual degree at the beginning of that season.

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[1] Italics mine.

The fact that Fin whales are more frequently infected than Blue whales on the South Georgian grounds, is amply borne out by these figures. While the number of whales examined was not large enough to be conclusive, however, the collection made by Mr Laurie in the 'Southern Princess' indicates that Blue whales are just as frequently infected farther south. Evidently the maximum of diatom infection is to be found at the maximum southern concentration of the given species of whale, and here we have but another expression of the fact that the centre of the southern concentration of Blue whales lies well to the southward of that of the Fin. The opinion that most of the Blue whales taken on the South Georgian grounds during the seasons studied, were on passage to and from other feeding grounds also gathers strength from these figures.

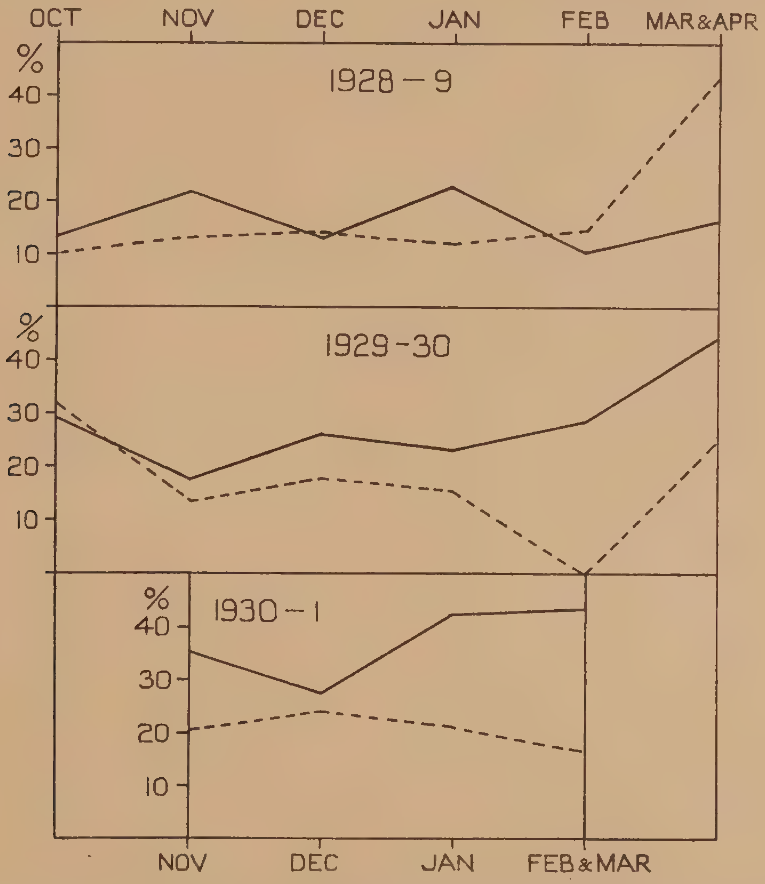


Fig. 6. The seasonal variation in the percentage of whales with thick film during the three seasons studied at South Georgia. Solid lines Fin whales, pecked lines Blue whales.

It will be seen from the small number of observations obtained at the South Shetlands at mid-season (p. 271) that the percentage of Fin whales with thick film was exceptionally high, while the percentage infection was quite normal. It follows that at the time the observations were made, the stock on those grounds must have been almost equally composed of individuals that had already spent some months in Antarctic waters and the forerunners of the great second wave of (mainly immature) arrivals from the north.

CORRELATION WITH FATNESS

It is not possible to demonstrate the correlation between heavy diatom infection and fatness by the most obvious methods, for the following reasons: if the fatness of whales bearing thick film is plotted against that of whales upon which no film was seen, the numbers in the latter group are usually small and unrepresentative of the stock as a whole. If the uninfected whales in any given month group happen to include a few pregnant females or newly weaned calves, the fatness ratio of which is always high, the figures tend to be entirely misleading, while, if such whales are disregarded, the numbers may be so small that it is certain they cannot give a true mean. The more obvious alternatives: plotting fatness of all infected whales against uninfected whales, or heavily infected whales against uninfected and slightly infected whales also fail, the first owing to the rapidity with which a slight degree of infection may be attained, and the second because it is not possible to be certain how much of the film has been lost after death in a whale which shows diatoms but is not heavily infected. These complications appear to be chiefly due to the constantly changing character of the whale population off South Georgia. Nevertheless, we have found that the gunners at South Georgia hold by Bennett's early observation, that whales upon which the infection is heavy tend to be in better condition than the others. This would no doubt be more readily apparent on the South Shetland grounds, which lie farther within the Antarctic Zone, and at which, therefore, the differences in condition between early and late arrivals from the north are likely to be much greater.

With these considerations in view it was decided that the only satisfactory way in which the correlation could be tested with regard to the South Georgian whales was to take the mean fatness of the total Fin whales in each month group as the nearest possible approach to a figure representative of the condition of such a mixed population, and to plot against them the mean figures for the heavily infected Fin whales. This has been tried with considerable success with the records of the 1928–9 and 1929–30 seasons, when as shown below the heavily infected Fin whales were fatter than the average in no less than ten out of the twelve month groups studied. The number of Fin whales taken during the very poor 1930–1 season was insufficient to test the correlation satisfactorily, and for the same reason little reliance could be placed on the Blue whale figures obtained at Grytviken during 1928–31.

The figures obtained by this method from the data of the 1928–9 season are plotted in Fig. 7, the solid line represents the mean fatness of the total Fin whales measured during each month, and the pecked line that of the Fin whales upon which heavy diatom film was observed. It will at once be seen that the heavily infected whales were fatter than the average except for the first month of the season. The most reasonable explanation of this exception lies in the probability that some of the whales remaining south through the winter, or arriving on the grounds very early, did not improve in condition before the diatoms got a grip on them. The solid line quite clearly shows the general improvement in condition of the whales as the season advanced, the temporary falling off in January being in accordance with expectation, as it is then that the incidence of the second wave of immigrants, consisting mainly of immature whales, was chiefly felt. It is true that the actual proportion of immature whales in the catches was highest in February (pp. 263–4), but it is believed that this was due partly to the disappearance of some of the mature whales, and partly to an invasion of immature whales moving (probably in a west to east direction, Kemp and Bennett, 1932, p. 180) within the Antarctic Zone. Not only was the condition of the whales caught in February better than that of those taken in January, but the percentage infection of the February whales was nearly as high (Fig. 3). Indeed it would seem from the diatom data that, during the 1928–9 season, the second wave of migration began as early as December with an unusually large proportion of mature whales, and that many of the later immature arrivals had already spent some time within the Antarctic Zone.

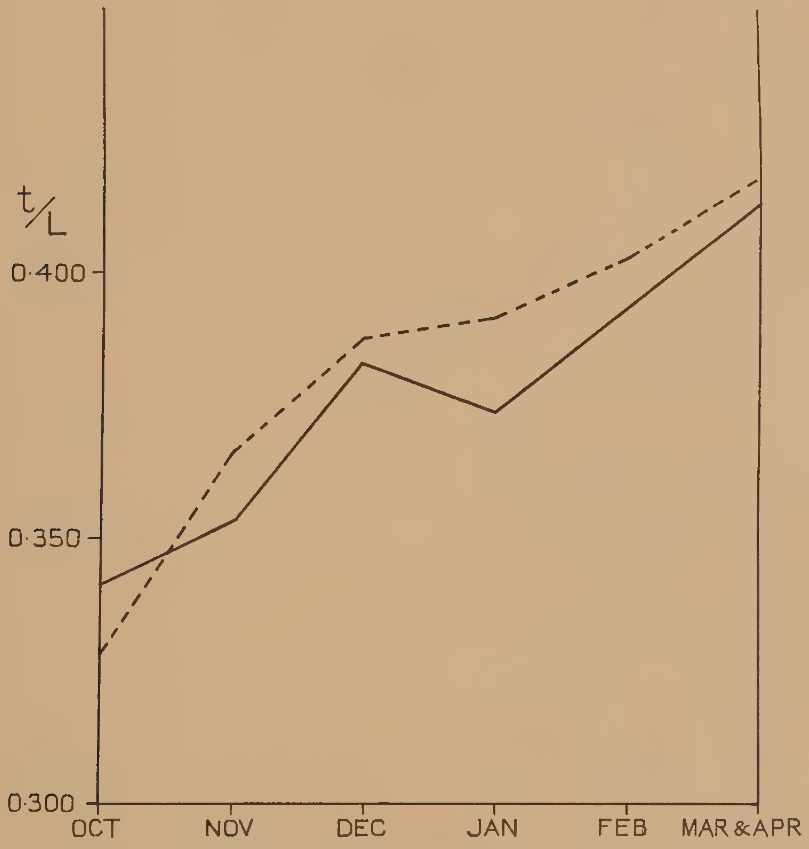


Fig. 7. Skin Diatom Fatness correlation, 1928–9. The average t/L % of Fin whales on which thick or extensive film was recorded each month is shown by the pecked line, while the continuous line represents that of the total Fin whales for which full data are available. t = Blubber thickness; L = Length of whale.

The course of events during the 1929–30 season, the fatness figures for which are plotted in Fig. 8, was evidently somewhat different. In the first month the condition of the Fin whales taken was fairly good, but they showed a steady decline until December, and after that a steady improvement till the end of the season. Heavily infected whales were leaner than the average in November, but considerably fatter in all the other months. Yet the proportion of immature whales increased markedly after the new year, and reached its maximum in February as usual, and from the diatom data it seems highly probable that a considerable proportion of the January arrivals came from the north. One is forced to the conclusion that the movements during this season were too complex to be followed in detail by the combination of indirect methods available, but that three strong probabilities are still detectable: firstly, that at the beginning of the season an unusually large proportion of the whales present had either wintered south, or arrived on the grounds before the season began; secondly, that there was a fairly constant replacement of these, mainly by mature whales that had not been long within the Antarctic Zone, throughout the first half of the season; and

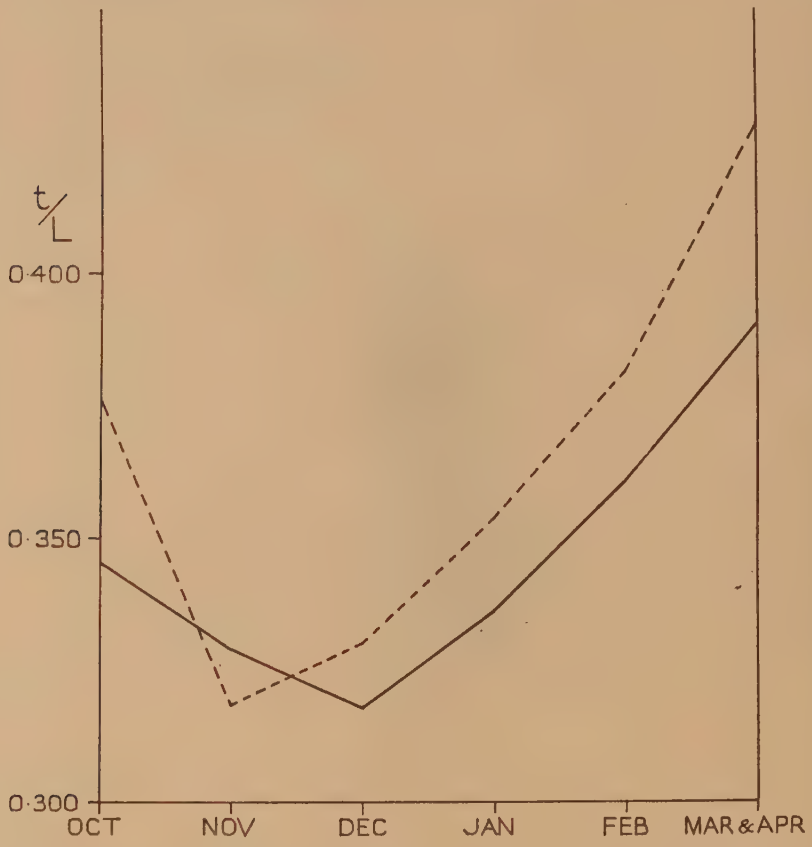


Fig. 8. Skin Diatom Fatness correlation, 1929–30. The average t/L % of all Fin whales with thick or extensive film is shown by the pecked line, while the continuous line represents that of the total Fin whales for which full data are available. t = Blubber thickness; L = Length of whale.

thirdly, that, as in the previous year, while some of the January immature arrivals undoubtedly came from the north, many of the later ones had been within the Antarctic Zone for a considerable time, and probably came from the westward. It may be thought that the opinion derived from diatom data, that some of the January immature arrivals came from the north, is inconsistent with the observation that the average condition of the total Fin whales taken during that month showed an improvement on the December figures, but the altogether exceptional poverty of the latter, and the still moderate proportion of immature whales in the January catch, render this objection untenable. The condition of the Fin whales in December of this season was indeed considerably poorer than in any of the other month groups studied, and if the solid lines in Figs. 7 and 8 are compared, it will at once be seen that from November onwards the condition of the whales taken in 1929–30 was appreciably poorer than that of those captured during the previous season. This is in striking agreement with one of Bennett's observations at the South Shetland Islands, quoted by Harmer (1931, p. 107), that during "big Fin whale years" the condition of the whales tends to be poorer than usual. The season 1929–30 was a big Fin whale year at South Georgia, the proportion of Fin to Blue in the total catch being more than five to one, as against a proportion of less than two to one during the previous season, as may be seen from the figures given in Table I.

The considerations set forth at length in this section seem to justify the conclusion that, with rare exceptions during the early part of the season, Fin whales heavily infected with diatoms tend to be in better condition than the average off South Georgia, a fact which is recognized by the whalers. Some of Mr Rayner's observations on whale-marking cruises show that at times when large schools of Fin whales are feeding together in calm weather it is quite possible to distinguish the film, when extensive, from the decks of a catcher. It follows that, by selecting the heavily infected whales, the gunners could render their companies good service, and at the same time avoid wastage of the stock by slaughter of immature whales, which as we have seen are rarely heavily infected before the last month of the season. Unfortunately such ideal conditions are very rare on southern whaling grounds, but when they do occur there seems little doubt that the gunners endeavour to exercise this discrimination.

SUMMARIZED CONCLUSIONS

The first part of this paper consists of an account of the occurrence of diatoms in the cutaneous investment of cetaceans in Antarctic waters. Though commonest upon Blue and Fin whales, there is evidence that diatom film may occur on almost all the species of Cetacea known to inhabit these seas. Besides the usual "skin film" form, *Cocconeis ceticola*, Nelson, two other diatoms have been observed in quantity sufficient to form film visible to the naked eye on rare occasions. These were a small indeterminate species of *Navicula*, seen on Blue, Fin, and Sperm whales, and *Cocconeis wheeleri*, n.sp., found only on Humpbacks, and named after its discoverer, Dr J. F. G. Wheeler. Besides these species, several diatoms have been found in the skin film that are thought to be true "constituent species", i.e. present during the life of the whale. The reasons for regarding these as true constituents of the skin film are discussed at length; the species are: *Lycmophora lyngbyei*, Ktz., *Cocconeis gautieri*, H.v.H., *C. imperatrix*, A. Sch., *Navicula* spp. and *Gyrosigma* (*Rhoicosigma*) *arcticum*, Cleve.

The formation of microspores in *Cocconeis ceticola* is described, and it is shown that spore formation is commonest at the beginning and end of the season. As it seems certain that diatom film is only formed upon whales in Antarctic waters, it is thought that these spores furnish the chief means of dispersal of the species. The small nucleus of whales known to remain in the far south during the winter would serve to maintain survival, and the shedding of vast quantities of microspores into the sea in the following spring, when the schools congregate on the feeding grounds, apparently leads to rapid reinfection of the new arrivals. Spore formation was at a minimum in January, but showed a great increase in February and March. Examination of Sei whales, which only come south late in summer, suggests that a period of about one month elapses between the arrival of whales within the Antarctic Zone and the formation of visible diatom film upon them. The great increase in spore formation at the end of the season will obviously tend to ensure that a majority of the whales that remain south through the winter become infected.

Systematic and general notes on all the species thought to be true constituents of the skin film have been given. The presence of numerous protoplasmic processes issuing from pores in the frustules of the principal species *Cocconeis ceticola* has been observed, and there are indications that it may rarely be actively parasitic upon the whales, penetrating the epidermis via old scar tissue. It is thought, however, that its normal mode of nutrition is holophytic, perhaps partially saprophytic upon epidermal cells which would have died naturally, whether the diatoms were present or not. *Navicula* sp.? was also observed to have penetrated the epidermis upon two occasions, with a markedly deleterious effect upon it.

A brief outline of existing knowledge of whale movements, with special reference to South Georgia, is then given. Southern Sei whales are known to make only a brief journey southwards towards the end of the whaling season, and the period of their maximum abundance round South Georgia falls in March. The general nature of the migration of the larger rorquals, southwards in summer to feed and northwards in winter to breed, has long been a matter of common knowledge, but further details remain practically unknown. There is some evidence that on the South Georgian grounds the general trend of movement is easterly. Blue whales show a strong southerly component in addition, which agrees with the observation, now well established, that the centre of concentration of Blue whales lies well to the south of that of Fin whales. There is a definite southward movement of the concentration centre of both species as the season advances. In some seasons the return movement towards warmer waters is well marked in the later months. The Blue whales commonly illustrate this movement more clearly than the Fin whales. The smaller whales, mostly immature, tend to lag behind on the southern migration and arrive in large schools, often segregated according to sex, after mid-season. They tend to replace the larger individuals which move farther south at this time.

The numerical data for the three seasons during which diatom infection was studied at South Georgia are given in summarized form. The catch has been divided into month groups, and the percentage of various classes of whales showing infection, thick film, spore formation, etc., has been calculated. Brief mention of two small series of observations in other localities has also been made.

In the following sections the seasonal variation in percentage infection and percentage with thick film are considered, and it is shown that the diatom data bear out the general idea of whale movement derived from other lines of enquiry. The incidence of the invasion of immature whales about mid-season is normally reflected in a temporary falling off in percentage infection, but some of the later arrivals are already infected, and probably come from the westward. Blue whales on their way north at the end of the season showed the highest percentage infection of all, in accordance with expectation. In general there is a steady increase in the proportion of infected whales throughout the season.

On the South Georgian grounds, Fin whales were found to be more liable to diatom infection than Blue whales, with the exception above mentioned. Scrapings collected on the ice-edge to the south of Africa indicate that farther south Blue whales are infected just as often. The conclusion is reached that during the seasons studied, the majority of the Blue whales taken were on passage to and from other feeding grounds farther south. Male Fin whales seem to be more often infected than the females, which is perhaps correlated with greater development of the schooling habit, particularly among the immature individuals. All these considerations point to the conclusion that the migratory movements of Blue whales are more regular and more extensive than those of Fin whales, mainly owing to their greater southerly range, amply demonstrated of recent years by the catches of the pelagic whaling fleet.

It has been possible to demonstrate the early observation of Bennett, that whales with heavy diatom film are in better condition than those without, by plotting the mean fatness of heavily infected Fin whales against that of the total Fin whales, for each month during the first two seasons studied at South Georgia. The heavily infected whales were appreciably fatter in ten out of the twelve month groups. The two exceptions occurred during the early part of each season, and were probably due to the nucleus of whales that remained south during the winter. Two other interesting points are well brought out by the fatness figures: the general improvement in the condition of the whales throughout the season, and a temporary decrease due to the invasion of immature whales at mid-season in 1928–9. They also afford concrete proof of another important early observation by Bennett, that the condition of Fin whales tends to be poorer in big "Fin whale years". The season 1929–30 was a big Fin whale year at South Georgia, and the marked inferiority in condition of the whales, as compared with that of those captured during the previous season, is very well brought out by the two graphs.

The general conclusion is reached that diatom data may be a valuable aid to other methods of studying whale movements, provided that a sufficiently large number of observations are considered. By itself the method will not provide reliable criteria, apart from the fact that any whale upon which the infection is readily visible, has spent at least one month within the Antarctic Zone.

I should like to record my grateful thanks to Dr Kemp for seeing the manuscript of this paper through the press during my absence abroad.

REFERENCES

Bennett, A. G. (with an Appendix by Nelson, E. W.), 1920. *On the Occurrence of Diatoms on the Skin of Whales.* Proc. Roy. Soc. B, xci, pp. 352–7.

Cleve, P. T., 1894–5. *Synopsis of the Naviculoid Diatoms.* K. Sevensk. Vet. Akad. Handl., xxvi, 2, xxvii, 3. Stockholm.

Deacon, G. E. R., 1933. *A general Account of the Hydrology of the South Atlantic Ocean.* Discovery Reports, vii, pp. 171–238, pls. viii–x, text-figs. 1–24.

Earland, Arthur, 1933. *Foraminifera. Part II, South Georgia.* Discovery Reports, vii, pp. 27–138, pls. i–vii, text-figs. 1–3.

Ghazzawi, F. M., 1933. *The Littoral Diatoms of the Liverpool and Port Erin Shores.* Journ. Mar. Biol. Assoc., n.s., xix, pp. 165–76.

Gran, H. H., 1912. *Pelagic Plant Life.* In Murray and Hjort: *Depths of the Ocean*, London.

Hamilton, J. Erik, 1914. *Report to the Committee appointed to investigate the Biological Problems incidental to the Belmullet Whaling Station.* British Assn. Rept. Section D, Australia, 1914, Ref. no. 6.

Harmer, Sir Sidney F., 1931. *Southern Whaling.* Proc. Linn. Soc. Lond., Session 142, pp. 85–163.

Hinton, M. A. C., 1925. *Report on the papers left by the late Major Barrett-Hamilton, relating to the whales of South Georgia.* Crown Agents for the Colonies, London, pp. 57–209.

Hustedt, Friedrich, 1930. *Die Kieselalgen....*1 Teil. In Rabenhorst's Kryptogamen-Flora von Deutschland, Österreich und der Schweiz, vii, Leipzig.

Kemp, S., and Bennett, A. G., 1932. *On the Distribution and Movements of Whales on the South Georgia and South Shetland Whaling Grounds.* Discovery Reports, vi, pp. 165–90, pls. vii–xlii, text-figs. 1–6.

Lebour, M. V., 1930. *The Planktonic Diatoms of Northern Seas.* Ray Society Monograph 116, pp. i–x, 1–244, pls. i–v, London.

Mackintosh, N. A. and Wheeler, J. F. G., 1929. *Southern Blue and Fin Whales.* Discovery Reports, i, pp. 257–540, pls. xxv–xliv, text-figs. 1–157.

Matthews, L. Harrison, 1932. *Lobster-Krill: Anomuran Crustacea that are the Food of Whales.* Discovery Reports, v, pp. 467–84, pl. iv, text-fig. 1.

Peragallo, Maurice, 1921. *Diatomées d'eau douce et Diatomées d'eau salée.* Deuxième Expéd. Antarct. Française (1908–1910) commandée par le Dr Jean Charcot. Botanique, pp. 1–96, pls. ii–vi.

Petit, Paul, 1889. *Diatomacées recoltés dans le voisinage du Cap Horn.* Mission Scientifique du Cap Horn, 1882–1883, v, Botanique, pp. 111–140, pl. 10.

Schmidt, A., 1890–1902. *Atlas der Diatomeenkunde*, 1–72, Leipzig.

Stanbury, F. A., 1931. *The Effect of Light of Different Intensities, reduced selectively and non-selectively, upon the rate of growth of* Nitzschia closterium. Journ. Mar. Biol. Assoc., n.s., xvii, pp. 633–53.

van Heurck, H., 1909. *Diatomées.* Resultats du Voyage du S.Y. 'Belgica' en 1897–9 sous le commandement de A. de Gerlache de Gomeroy. Rapports Scientifiques: Botaniques, pp. 3–126, pls. ii–vi.

Wheeler, J. F. G., 1930. *The age of Fin Whales at Physical Maturity.* Discovery Reports, ii, pp. 403–34, pl. v, text-figs. 1–5.

EXPLANATION OF PLATE XI.

Fig. 1. Large type *Cocconeis ceticola*, Nelson, from a Fin whale: × 200.

Fig. 2. *Cocconeis ceticola*, Nelson. Girdle view, showing protoplasmic processes: × 1000.

Fig. 3. *Cocconeis ceticola*, Nelson. Spore formation and free microspores: × 1000.

Fig. 4. Penetration of the epidermis of a Blue whale by *Cocconeis ceticola*.

Fig. 5. *Cocconeis wheeleri*, n.sp., from a Humpback whale: × 200.

Fig. 6. *Cocconeis wheeleri*, n.sp. Lower valve: × 1000.

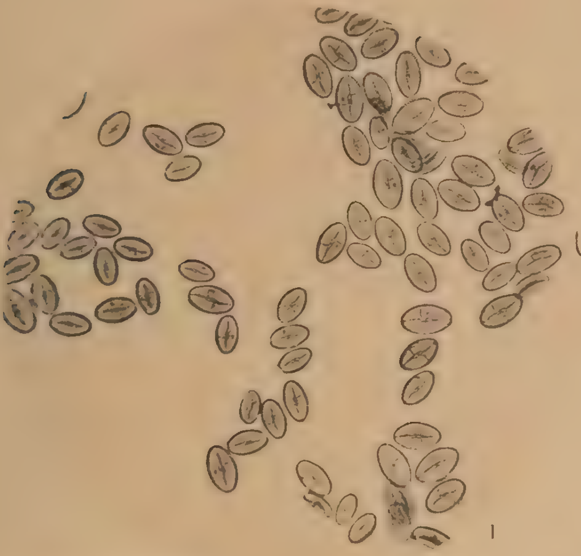
Fig. 7. *Cocconeis wheeleri*, n.sp. Girdle view: × 1000.

Fig. 8. Penetration of the epidermis of a Sperm whale by *Navicula* sp.

Fig. 9. Small *Navicula* with *Cocconeis ceticola*, from a Fin whale: × 430.

Fig. 10. *Gyrosigma arcticum* with *Cocconeis ceticola*, from a Fin whale: × 200.

Figs 1, 5 from photos by J. F. G. Wheeler: Figs. 9, 10 from photos by A. Saunders.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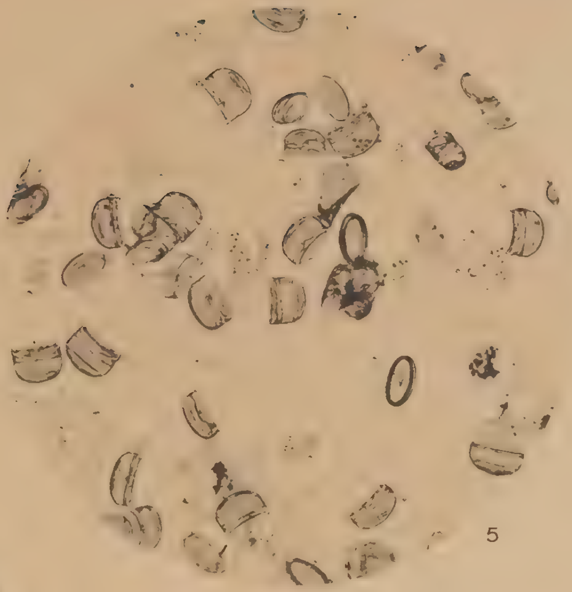
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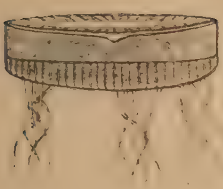
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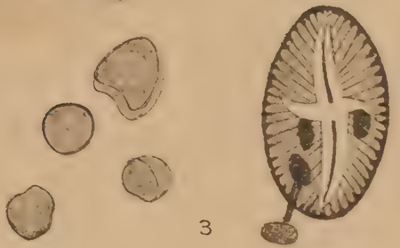
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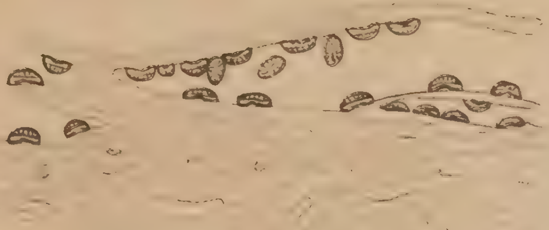
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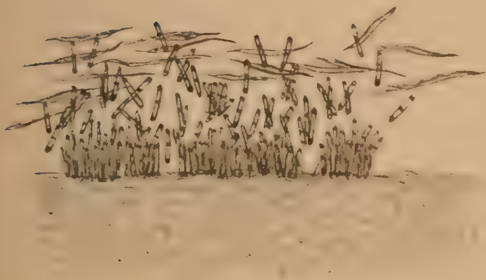
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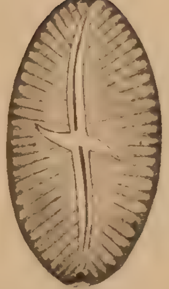
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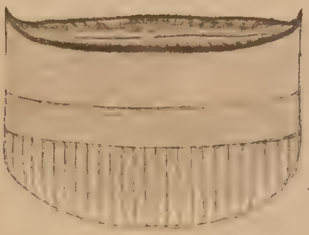
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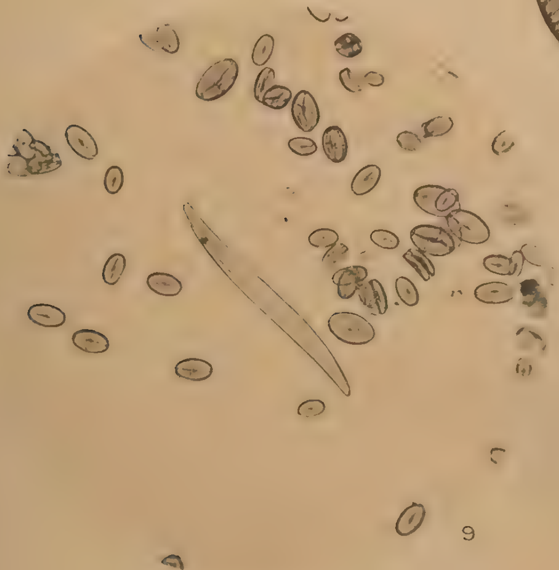
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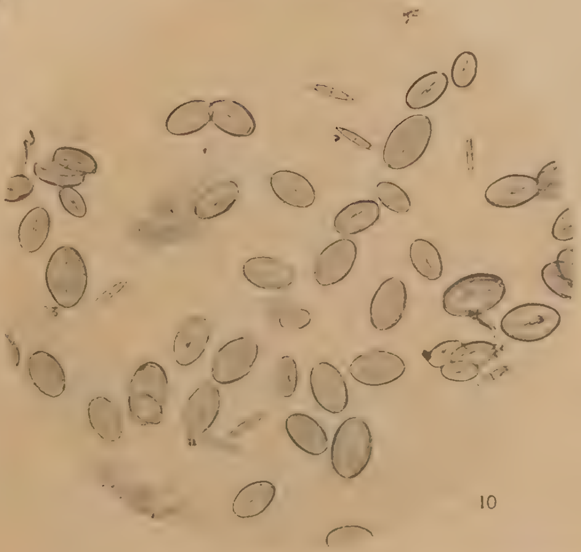
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DIATOMS OF THE SKIN FILM OF WHALES.

[*Discovery Reports. Vol. X, pp.* 283–382. *Plates XII–XXV, Chart I, November,* 1935.]

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THE SOUTH ORKNEY ISLANDS

By

JAMES W. S. MARR, M.A., B.Sc.

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THE SOUTH ORKNEY ISLANDS

By James W. S. Marr, M.A., B.Sc.

(Plates XII–XXV; text-figs. 1–10)

INTRODUCTION

Accounts of a running survey of the South Sandwich Islands and of survey operations in other Dependencies of the Falkland Islands have already appeared in the *Discovery Reports*.[1] On the second commission of the R.R.S. 'Discovery II', 1931–3, according to instructions received from the Discovery Committee, the month of January 1933, was set aside for survey work. The instructions were that we should make a survey of the South Orkney Islands; or that if we found the ice or weather conditions around that group unfavourable we should go on to the South Shetland Islands and continue there the survey work begun during the first commission of the R.R.S. 'Discovery II'.[2]

The last months of 1932 were occupied in making a hydrological and planktonic survey of the waters of the Falkland sector of the Antarctic, and in the course of that work we found the South Orkney Islands to be completely free of ice at the unusually early date of November 22. The edge of the Weddell Sea pack-ice lay seventy miles to the south of them. They were ice-free when we returned to them on January 2, 1933, and between that date and January 29 a hydrographic survey of the group was made.

Prior to the survey of 1930 by the R.R.S. 'Discovery II' the Admiralty Chart of the South Sandwich group was based upon the work, a century old or more, of Cook and Bellingshausen. Although the shape and position of the South Orkneys were based upon more recent work, in the latest Admiralty charts[3] of the group there still appeared the legend: "Caution is necessary in approaching the South Orkneys as their charting is only approximate."

In compiling the history of these islands I was fortunate in obtaining from many quarters valuable assistance which I have now much pleasure in acknowledging. Among the many who have helped I wish first of all to thank Lieutenant-Commander R. T. Gould, R.N. (Retd.), whose peculiar knowledge of the more out-of-the-way facts of Antarctic history has been placed unreservedly at my disposal and whose unpublished notes, now in the possession of the Hydrographic Office, on the early cartography of the

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[1] Kemp, S., and Nelson, A. L., 1931, *The South Sandwich Islands*, Discovery Reports, III, pp. 133–90. Chaplin, J. M., 1932, *Narrative of Hydrographic Survey Operations in South Georgia and the South Shetland Islands*, 1926–30, Discovery Reports, III, pp. 297–344.

[2] Kemp, S., 1932, *The Voyage of the R.R.S. 'Discovery II': Surveys and Soundings*, Geog. Journ., LXXIX, pp. 168–81.

[3] Chart No. 3175, Admiralty, March 7, 1901, corrected to June 3, 1927.

South Shetlands and the South Orkneys and on the place names of the South Orkneys, have rendered the task of writing this history from a somewhat scattered and inaccessible literature much easier than it would otherwise have been. To Mr Bjarne Aagaard, of Stavern, Norway, who has helped in many other ways, I am particularly indebted for the account of C. A. Larsen's visit to the South Orkneys in November 1892, and for his kindness in introducing me to Captain Walter Sachse of Hamburg, formerly Navigating Officer of the 'Valdivia'. It was largely through the efforts of Captain Sachse that I was able to examine the log-book of the German explorer and sealer, Captain Eduard Dallmann of the steam whaler 'Grönland'. After some enquiry Captain Sachse succeeded in locating this log-book in the library of Justus Perthes' Geographische Anstalt in Gotha, from which it was kindly lent to me by Professor Paul Langhans. The section on whaling owes much to correspondence with Mr Sigurd Risting, Secretary of the Association of Whaling Companies, Sandefjord, Norway, who together with other information has supplied me with many interesting facts concerning the harbours and roadsteads used by the Norwegian whaling fleets at the South Orkneys, and with details of the Norwegian hydrographic work in the group. In collecting this information Mr Risting made many enquiries among the Norwegian whaling community, obtaining much that was of historical interest from several of the captains who had worked at the South Orkneys during the early days of whaling in that field, particularly from Mrs Signy Sörlle, whose husband, the late Captain Petter Sörlle, had made surveys there.

There are many others to whom I am grateful for assistance, and in particular I would mention Captain J. B. Harrold, O.B.E., R.N.R., the Registrar-General of Shipping and Seamen, who from the records in his office succeeded in tracing the name of the captain of the cutter 'Beaufoy' in December 1821, when she made a voyage of discovery into the north-western corner of the Weddell Sea. In addition Captain Harrold was able to clear up certain points regarding the ownership of the two vessels, the 'Jane' and the 'Beaufoy', commanded by Weddell in 1822–4. For further information on these points I am indebted to Mr G. Walker, Secretary of the Royal Scottish Geographical Society, who kindly examined for me some letters from Weddell and a manuscript of his life belonging to that Society. I have also to express my thanks to Monsieur G. Grandidier, Secrétaire Général, Société de Géographie, Paris, for notes on Powell's life and death and on the French hydrographic work at the South Orkneys, to the President and Council of the Royal Geographical Society for permission to use their library, and to Mr D. B. Smith, librarian at the Admiralty.

Mr J. M. Wordie has kindly read through the manuscript of this paper, and to him and to Mr D. D. John, who was in charge of the scientific work during our survey of the South Orkneys, I am much indebted for valuable criticism and help.

Finally I wish to thank the Hydrographer of the Navy, Rear-Admiral J. A. Edgell, R.N., and Commander N. A. C. Hardy, R.N., Superintendent of Charts, for the opportunity of examining the early charts of the South Orkneys.

HISTORY OF THE ISLANDS

The discovery of the South Orkney Islands was a direct result of the rapid rise and decline of the great southern sealing industry which followed in the wake of Smith's discovery of the South Shetlands in February 1819. The slaughter of the fur seal, having begun quietly in January 1820, had reached such a pitch the following summer, 1820–1, that many sealers had the greatest difficulty in obtaining full cargoes of skins in the season 1821–2. Weddell,[1] while deploring the ruthless conduct of the industry at its inception and uttering a tardy exhortation for scientific control, states that by the beginning of 1822 the fur seal had become nearly extinct. The meagre cargoes which, as Bruce records,[2] were brought back to England in 1822 give a further indication of the disastrous depletion that had occurred in the fur seal stock during the single summer season 1820–1. The extent of the slaughter that took place during this season is well illustrated by Bruce's figures. On April 5, 1821, he records, Captain George Powell in the cutter 'Eliza', one of at least forty-seven British and American sealing vessels, brought to London between 16,000 and 18,000 fur sealskins. Of the following season, 1821–2, Powell himself writes:[3]

> ...we had a very favourable passage down, and arrived on the 30th [of November at Elephant Island]; but saw no prospect of getting many seals, for the boats that I left here had not obtained more than 150 skins. There was no time now for hesitating about the matter, for all the land that had yet been discovered would not afford skins enough for one vessel, although there were so many taken last season; the skins are now more scarce, but I believe the ships and vessels that are here for them this season are many more than last.

Webster,[4] who visited the South Shetlands in the 'Chanticleer' in 1829, refers to the very swift decline of the industry in the following passage:

> The harvest of these seas has been so effectually reaped, that not a single fur seal was seen by us, during our visit to the South Shetland group; and, although it is but a few years back since countless multitudes covered the shores, the ruthless spirit of barbarism slaughtered young and old alike, so as to destroy the race. Formerly two thousand skins a week could be procured by a vessel; now not a seal is to be seen.

Such, then, was the magnitude of the slaughter, by Americans and British alike, which came very near to exterminating the South Shetland fur seals in the summer months of 1820–1.

In these circumstances, therefore, it is not surprising that even as early as the end of 1821 the more enterprising masters of sealing vessels, having gleaned all the beaches then known in the South Shetlands as far east as the Elephant and Clarence group and having met with little success in the more rugged and inaccessible lands to the south and south-west of the Bransfield Strait, began to push still farther eastward in search of new hunting grounds. It was such a voyage to the eastward that led to the discovery of the South Orkney Islands in December 1821.

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[1] Weddell, J., 1827, *A Voyage towards the South Pole*, 2nd ed., pp. 141–2 (London).

[2] Bruce, W. S., 1920, *Report of the Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands*, Appendix II, pp. 38–9 (London).

[3] Powell, G., 1822, *Notes on South-Shetland, etc.*, p. 7 (London).

[4] Webster, W. H. B., 1834, *Narrative of a Voyage to the Southern Atlantic Ocean in the years* 1828, 1829, 1830, II, pp. 302–3 (London).

George Powell,[1] who discovered and made the first chart of the South Orkneys, was an English sealer who had made at least two voyages into the Antarctic. Of his ancestry and early life nothing appears to be known. He was born about 1795[2] and went to sea at an early age. In the summer of 1820–1 he was at the South Shetlands, being then in the employment of one Bennett, in honour of whom he afterwards named a cape at the South Orkneys. Of this voyage there is no record, but he obviously took his full share in the general massacre which occurred then, for he returned to London in April 1821 with a rich cargo of fur sealskins in the cutter 'Eliza'. The following season he was again at the South Shetlands with the 'Eliza' and the sloop 'Dove', in which on December 6, 1821 he discovered the South Orkneys.[3] He returned to London on August 26, 1822. In 1824 he was in the Pacific Ocean engaged in exploratory work and sperm whaling in a ship called the 'Rambler', but on April 3 of that year, at Vavau in the Tonga group, while endeavouring to retrieve certain members of his crew who had deserted, he was suddenly set upon by natives and killed. The manner of his death, which is described by Michaud as most horrible, recalls that of Captain Cook. He was only twenty-nine years old and in Michaud's words "son ardeur entreprenante et son instructions promettaient un marin distingué".

For various reasons Powell's work in the south did not for a long time receive the full recognition that would appear to be its due, except perhaps by the French.[4] His *Notes on South-Shetland, etc.*, pp. 3–12, which was printed to accompany his general chart of that group (p. 289, footnote 3), is the only published work by Powell that exists.[5] It comprises a short editorial preface and extracts from the journal (no longer extant) which he kept during his voyage to and from the South Shetlands during the years 1821 and 1822. The actual extracts concern the South Shetlands and South Orkneys only, but mainly the latter. The meagre record he has left and the little that is known of his life, his early death which occurred less than two years after the completion of his Antarctic voyage of 1821–2, and the probability that his work may have been overshadowed by Weddell's more spectacular high southern record in 1823, are all factors that may well have contributed towards keeping his name in undeserved obscurity.

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[1] For certain of these biographical details the author is indebted to L. G. Michaud's account of Powell's life in *Biographie Universelle*, 1845, pp. 253–4 (Paris), kindly communicated by the secretary of the French Geographical Society, to whom acknowledgment is made.

[2] He may have been a Londoner, for in the Prefatory Remarks, p. 3, to *Notes on South-Shetland, etc.*, the publisher makes acknowledgment for the extracts from Powell's journal to a Mr Lewthwaite, teacher of navigation of Princes Street, Rotherhithe, with whom Powell had apparently left his private papers.

[3] For full details of the discovery see pp. 295 *et seq.* The statement in *North and South Atlantic Memoir*, 1844, Section VII, p. 225 (Blachford and Imray, London), that Powell, in 1821, discovered Trinity Land, south of the South Shetlands and the South Orkneys, between 60° 30′ and 61° S, and 44° 30′ and 46° 30′ W, is quite meaningless: the South Orkneys themselves lie in this position.

[4] Balch, E. S., 1901, in *Antarctica: A history of Antarctic discovery*, Journ. Franklin Inst., CLI, p. 321, has the following footnote: "It is a singular fact that Powell appears to have received more recognition from the French than from his own countrymen. An account of his life may be found in the *Biographie Universelle, Supplément*, Paris, L. G. Michaud, 1845....Jules de Blosseville, Lieutenant de Vaisseau, wrote a long appreciative notice of Powell: *Mort du Capitaine Georges Powell*; Revue des Deux Mondes, III année, Tome I, Paris, 1831, pages 38–46."

[5] Michaud (*loc. cit.*) states that Powell also published *Sailing Directions for the Straits of Magellan*, from which it would appear that on one or other of his Antarctic voyages he had made surveys in and about the Patagonian Channels.

It is only since the beginning of this century that modern geographers, particularly Bruce,[1] have drawn attention to his undoubted ability.

He was one of the few sealers who kept an accurate journal and his *Notes on South-Shetland*, although short, is a pamphlet of considerable value; it constitutes one of the very few reliable records of discovery and sealing in this period and is freely quoted in this report. It is of great assistance in unravelling the rather complicated early history of a region in which questions of priority of discovery have become confused owing to the publication of verbal accounts of sealers in a distorted form.[2]

Powell appears to have been a sailor of more than ordinary ability. In the course of his second Antarctic voyage, during the summer season of 1821–2, he made surveys resulting in the publication of the first reliable chart of the South Shetlands,[3] a considerable and extremely creditable work in the construction of which he must have employed every moment of the scanty time he could snatch from his arduous occupation as a sealer. It was not, however, the result of his own work entirely, for Powell was acquainted only with the northern side of the archipelago, a fact he is careful to point out in the full acknowledgment he makes for help received in laying down its southern coast-line on his chart. He says:

> I have not been on the south-side of the land [South Shetlands] myself, but I received my information respecting it from the descriptions and sketches of my friends, Captain John Walker, Captain Ralf Bond, and Mr Charles Robinson; and, by comparing these documents together, and the information I have received from other masters of vessels, I conclude that the description will be found exact.

In view of these remarks Purdy's comment on Powell's chart is also of some historical interest. He writes:[4]

> *The first chart of these Islands*, for the use of navigators, was constructed by the late Mr Geo. Powell, commander of the ship Dove, and published by Mr Laurie, in 1822. In the composition of it, exclusive of his own observations and sketches, Mr Powell was materially assisted by several

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[1] Bruce, W. S., 1917, *The Weddell Sea: An Historical Retrospect*, Scott. Geog. Mag., XXXIII, No. VI, pp. 248–9.

[2] Cf. Fanning's account of N. B. Palmer's voyage to the South Orkneys in 1821, *infra*, p. 299.

[3] *Chart of South Shetland, including Coronation Island, etc., from the exploration of the Sloop Dove, in the years* 1821 *and* 1822 *by George Powell, Commander of the same.* Published by R. H. Laurie, November 1st, 1822. The first chart of the South Orkneys, under the name of "Powell's Group" from the survey by Powell, was included in this chart, as the title suggests.

[4] Purdy, J., 1845, *The New Sailing Directory for the Ethiopic or Southern Atlantic Ocean*, 3rd ed., revised and corrected by Alex. G. Findlay, Section I, p. 155 (London, R. H. Laurie).

intelligent commanders, both English and American, and he has added to the islands properly *South Shetland*, another group, considerably more to the East, which he discovered on the 6th of December, 1821.

Powell, it must be observed, was by no means the first explorer of the South Shetlands, nor was his chart of that group the first to be published. Smith, Bransfield, Sherrat, Weddell and Bellingshausen had all been engaged in the preliminary charting of the group before Powell commenced his observations there at the beginning of the season 1821–2, and some, although by no means all, of the results of these early explorers had already been published when Powell's chart made its appearance on November 1, 1822. The vague sketch-map of the discoverer, William Smith, had already appeared in the *Edinburgh Philosophical Journal* in 1820,[1] and a somewhat grotesque chart of "New South Shetland"[2] by Captain R. Sherrat had been published by Fisher in London on December 21, 1821. On the other hand the results of Edward Bransfield's survey, which took place in January to March 1820 before Powell ever arrived at the South Shetlands, were a long time in appearing and actually were not published by the Admiralty until November 30, 1822,[3] almost a month after the appearance of Powell's chart. Weddell's observations, although actually begun about a year before Powell's, were extended off and on over a period of about three years from the end of 1820 until the end of 1823 and his chart was not published until 1825.[4] The results of the very accurate running survey of the southern side of the group carried out by Bellingshausen in February 1821 were still longer in appearing and were not published in St Petersburg until 1831.[5] Nevertheless, of all these early charts Powell's is so much the superior[6] in scope, accuracy, and wealth of detail that it may justly be regarded as being by far the most important contribution to the contemporary hydrography of this region.

It is clear that Powell had interests far beyond his daily business of sealing, for Michaud records that he collected specimens of soil from the South Shetlands for the Royal Society, and in his own journal he makes frequent reference to his soundings (of which he took a considerable number both at the South Shetlands and the South Orkneys), the state of the tides, and the set and strength of currents. On p. 4 of his *Notes* he reveals an undoubted interest in oceanography: "We sounded, and found no bottom at 195 fathoms. At the time of sounding, I attached my apparatus to the deep-sea lead-line, in order to ascertain the temperature of the sea, which, on taking up, I found to be 34° at that depth, while on the surface it was but 32°, and the temperature of the air 38°: the barometer stood at 29·54." This is probably one of the earliest references to the warm deep current with which we are now so familiar in the Antarctic, and it is extremely interesting to note that the editor of Powell's *Notes*, referring to the above phenomenon in a footnote on p. 4, says: "In the Sea of Spitzbergen, in the north, as in the Antarctic Ocean, in the south, the temperature of the sea-water increases with the depth; so that, when the thermometer at the surface stood at 32° or 33°, at 300 fathoms it was 36° or 37°." He goes on to point out that in confined seas in the north, disconnected with the warmer oceanic waters, the temperature was generally found to decrease with the depth. Moreover, for a sealer Powell kept a creditable meteorological log, noting the air temperature, barometric pressure, and surface temperature of the sea at noon and midnight.

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[1] Miers, J., 1820, *Account of the Discovery of New South Shetland, with observations on its importance in a Geographical, Commercial, and Political point of view: with two Plates*. Edin. Phil. Journ., III, plate xii, fig. 2, p. 367.

[2] This chart accompanied an article by Sherrat in the Imperial Magazine, Vol. III, 1821.

[3] Gould, R. T., 1925, *The First Sighting of the Antarctic Continent*, Geog. Journ., LXV, No. 3, p. 221.

[4] See p. 132 of the first edition of Weddell's book *A Voyage towards the South Pole*, in which his chart of the South Shetlands facing p. 128 appeared for the first time.

[5] See Mill, H. R., 1905, *The Siege of the South Pole*, pp. 128–30 (London). Bellingshausen's chart of the South Shetlands first appeared in his Atlas (plate 62) which was published in St Petersburg in 1831; but his excellent work on the southern side of the South Shetland archipelago was not generally recognized until long afterwards.

[6] Except of course for his southern coast-line, which is inferior to Bellingshausen's for the obvious reason that Powell in his construction of it had to rely on the information of others. Bruce, in *Report of the Inter-departmental Committee on Research and Development*, 1920, p. 34, regards Bellingshausen's as the best of the early running surveys of the southern side of the group.

His description of Bridgeman Island, an island then (December 1821) actively volcanic but now quite cold, apart from its considerable geological interest is well worth quoting if merely for the sake of showing what a careful observer he was.

> This island is volcanic; for when it bore S. by W., by compass, and distance 9 miles, it appeared to emit smoke from five craters; but, when it bore N.N.E., and distance one mile and a half, I could plainly see it was but one crater, of immense width, from which the smoke issued in dark volumes: after passing from this crater, the smoke branched off into the different columns of the rocks, and ascended upwards; it was this circumstance that gave it the appearance of five craters in a S. by W. direction. Bridgman's Island is about 200 feet high, and about four miles in circumference: the crater is situated on the west-side of the island, and is about 80 or 90 feet from the surface of the sea: the whole of the island assumes the appearance of burnt bricks:[1] the S.W. point is low, and was covered with penguins.

Powell's attitude to his new discovery, far from being merely commercial, appears to have been rather that of a geographer. It should be recalled that the South Orkneys were discovered at a time when it was still uncertain whether the South Sandwich Islands were in fact islands or a northerly projection of a continental mass;[2] for, although Bellingshausen had already proved the insularity of Cook's "Sandwich Land" in December 1819,[2] this fact had not been published at the time of the discovery of the new group.[3] One of the chief problems which confronted the explorers and exploring sealers of this period was to establish whether the land discovered by Smith in February 1819 (the South Shetlands) was or was not continuous to the eastward with "Sandwich

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[1] Charcot, cited on p. 59 of *The Antarctic Pilot*, 1st ed., 1930 (London), describes this island as being tinted by brick-red tufa. The French expedition under Dr Jean Charcot landed on Bridgeman Island in December 1909, but failed to find the slightest trace of volcanic activity.

[2] See Kemp, S., and Nelson, A. L., 1931, *The South Sandwich Islands*, Discovery Reports, III, p. 139.

[3] See Mill, H. R., 1905, *The Siege of the South Pole*, p. 129 (London).

Land". This is evident from Captain Shirreff's instructions to Edward Bransfield, of which the following is an extract:

> You are to proceed to about the latitude of 62° South and 62° West to discover and ascertain the extent of that tract of land there seen by Mr Smith in October last and whether it be merely an island or part of a continent; if the latter you will explore the land to the eastward and determine if it be connected with Southern Thule and Sandwich Land.[1]

These instructions were issued to Bransfield on board H.M.S. 'Andromache' at Valparaiso on December 19, 1819. There is little doubt, however, that an expedition such as this would have been despatched at an even earlier date but for the extreme scepticism with which Smith's original notice of his discovery was received in Valparaiso by the English, "who all ridiculed the poor man for his fanciful credulity and his deceptive vision". It was only after two further attempts to reach the South Shetlands, on the second of which he actually succeeded in landing, that Smith was at length able, in November 1819, to convince his countrymen in Valparaiso of the reality of his discovery. Then considerable interest was indeed aroused and swift action taken by the naval authorities at Valparaiso in equipping the 'Williams'[2] under Bransfield for a more thorough investigation of this new southern land. It is evident too that speculation was rife as to the true nature of the land which Smith had seen, whether it was the long-sought-for Southern Continent or merely a group of islands, for Miers, writing from Valparaiso in January 1820, remarks:

> As yet it remains an interesting topic of conversation, whether New Shetland be an island of considerable size, or if it be part of a continent. It is by no means an improbable supposition that it is connected with Southern Thule, the most southerly point of Sandwich Land seen by Captain Cook in 1775,...and it is by no means unfair to conclude, that New South Shetland and Sandwich Land form two points of one large continent.[3]

Although the South Shetlands were already known to be islands in 1821, the possibility still remained that the rather vague coast-line[4] to the south of the Bransfield Strait might be connected with "Sandwich Land", and moreover that new land such as the South Orkneys might form an important link in the event of such a connection. Of this possibility Powell may be assumed to have been aware. At all events, while Palmer,[5] if we are to believe Fanning, perhaps imagined that his "Palmer's Land" extended at least as far east as, and was connected with, the South Orkneys, Powell had a much clearer conception of his discovery; for he correctly supposed it to be a group of islands although he regretted that he was unable through lack of provisions to ascertain its easterly extent.[1]

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[1] Ida Lee (Mrs Charles Bruce Marriot), 1913, *The Voyages of Captain William Smith and others to the South Shetlands*, Geog. Journ., XLII, p. 367. See also Gould, R. T., 1925, *The First Sighting of the Antarctic Continent*, Geog. Journ., LXV, pp. 220–5.

[2] The brig 'Williams' in which Smith discovered the South Shetlands. See Miers' account of the discovery in Edinburgh Philosophical Journ., III, 1820, pp. 367–80.

[3] Miers, J., *loc. cit.*, pp. 377–8.

[4] The Trinity Land of Bransfield and the "Palmer's Land" of Fanning and others.

[5] N. B. Palmer, an American sealer, who accompanied Powell to the eastward in December 1821 (see p. 294).

> The eastern land [Laurie Island] extends to the eastward of Cape Hartree as far as we could discern, forming, as I suppose, a group of islands; for the sea, to the southward of the land was full of ice, floating about. I would have proceeded further to the eastward, but the wind being from the E.N.E., and all our stock of provisions exhausted, I was forced, with reluctance, to quit my object.

Powell did not find a single fur seal at the South Orkneys, but this circumstance, as far as can be gathered from his journal, does not seem to have caused him any regret. On the contrary his chief concern appears to have been the exploration of the group; and when he was at length compelled to leave, shortage of food did not deter him from standing due south into the Weddell Sea as far as 62° 20′ S, where heavy pack-ice obliged him to turn westwards towards the South Shetlands.

In the concluding lines of his *Notes on South-Shetland* Powell appears to throw a certain light, where all is vague, on a problem that has attracted the attention of the earlier historians of this region—particularly Balch and Nordenskjöld: the problem of the nature and extent of N. B. Palmer's discoveries on the southern side of the Bransfield Strait; and a brief discussion of this matter, at least in so far as it appears to be interpreted by Powell, is perhaps not exceeding the purpose of this paper. Palmer in the 'Hero' first appears to have explored the land to the south of the Bransfield Strait in January or February 1821,[2] and later, as nearly as we can judge now, in November of the same year (see p. 303) to have sailed along and considerably extended his exploration of it in the 'James Monroe'. Part of the land he had explored, however, had previously been discovered and named "Trinity Land" by Bransfield on January 30, 1820,[3] at least a year before Palmer's discovery in the 'Hero', an important fact of which Powell, judging from his concluding remarks, was evidently unaware:

> Of the land to the southward, called PALMER'S LAND, very little can be said, as it does not appear to be sufficiently explored: but it has been described as very high, and covered with snow, with inlets, forming straits, which may probably separate the land, and constitute a range of islands, similar to those of South-Shetland; at least, such is the appearance of the northern side, which alone has yet been seen.

Thus more than a hundred years ago Powell, although he had never been near the south side of the Bransfield Strait but had evidently held conversation with some who had,[4] appears to have entertained a shrewd opinion as to the possible nature of the land with which Palmer was acquainted—that it was perhaps an archipelago, so that after all the "Palmer's Land" which appears vaguely in Powell's chart of 1822, in part at any rate, need not have been the mainland of "West Antarctica" or Graham

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[1] Cf. the editor of Powell's *Notes*, p. 3: "How far Powell's Group may extend to the eastward is yet unknown, and we are equally ignorant of the extent of Palmer's Land, both to the south, east, and west".

[2] Balch, E. S., 1909, *Stonington Antarctic Explorers*, Bull. Amer. Geog. Soc., XLI, p. 478. According to Balch, however (*Antarctica Addenda*, Journ. Franklin Inst., CLVII, p. 85), he had already sighted it not very long before from a peak in Deception Island.

[3] Gould, R. T., 1925, *The First Sighting of the Antarctic Continent*, Geog. Journ., LXV, pp. 220–5.

[4] For instance, almost certainly with his co-voyager to the South Orkneys, Palmer himself.

Land as Balch[1] and Nordenskjöld[2] so stoutly maintain. It may indeed have been the archipelago which now bears Palmer's name, and in Powell we would appear to have an excellent authority for retaining this name, The Palmer Archipelago, in the present Admiralty charts. The whole truth of this matter is very difficult to ascertain, for Powell's chart offers little in support of his remarks. Of his "Palmer's Land", which he apparently plotted from the scraps of information he could gather, the most westerly part in 62° W might be taken as representing Brabant or Liège Islands and the rest extending eastwards to 57° 30′ W, although far to the south of any known coast, might with difficulty be regarded as the north coast of the present Trinity Peninsula, which at two separate points, in 60° W and 57° 30′ W, had already been discovered and much more accurately charted by Bransfield in January and February 1820.[3] Palmer may possibly have discovered part of the Trinity Peninsula on his second voyage in the 'James Monroe' in November 1821, but since this voyage has been hopelessly confused with the part he played in the discovery of the South Orkneys, it is more appropriately discussed in the section which now follows (see p. 302). For the moment, where other evidence on Palmer's achievement is either lacking entirely or deplorably vague, the opinion of Powell should not be disregarded, for it is the opinion of one who was personally acquainted with Palmer and was his partner in a voyage of exploration.

NINETEENTH-CENTURY EXPLORATION

GEORGE POWELL AND NATHANIEL BROWN PALMER

On November 30, 1821, Powell in the 'Dove' arrived at Elephant Island where he found the American sloop 'James Monroe', commanded by Nathaniel Brown Palmer of the Stonington sealing fleet. Sealing had been bad, and accordingly at Powell's suggestion the two commanders arranged to sail eastwards in search of new land and fresh hunting grounds.

Powell's wisdom in inviting Palmer to accompany him is obvious, as it would have been imprudent to venture a single vessel unsupported into an unknown sea sure to be fog-ridden and beset with ice, and the readiness with which the American vessel was prepared to assist the British is a strong indication that good relations existed between the two nations while carrying on their trade in the face of common hardship and danger. McNab[4] also records how the English and American bay whalers used to work amicably together and were often of mutual assistance.

The two vessels, having searched Clarence Island in their boats without finding a single fur or elephant seal, left Cape Bowles on the night of December 3 and proceeded to the eastward. Thick fog compelled them to heave to on the night of the 4th and during the stoppage the Americans, having run short of water, were supplied with 120 gallons from the 'Dove'. The weather remained thick for seventeen hours and it was not until the afternoon of the 5th that they could resume their easterly progress:

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[1] Balch, E. S., 1925, *The First Sighting of West Antarctica*, Geog. Rev., xv, pp. 651–2.

[2] Nordenskjöld, O., 1911, *Die Schwedische Südpolar-Expedition und ihre Geographische Tätigkeit*, I, Lief. I, pp. 40–1 (Stockholm).

[3] See Gould, R. T., 1925, *loc. cit., supra*, pp. 220–5.

[4] McNab, R., 1913, *The Old Whaling Days. A History of Southern New Zealand from 1830 to 1840*, pp. 197–8 (Melbourne and London).

> At 3 p.m. the sky began to break to the N.W., and by 4 p.m. the fog had cleared away, so that we could see four or five miles, we then bore away East under easy sail; at 4h. 30m. p.m. the fog was quite cleared away, and the sun made his appearance; at 4h. 40m. got sights, and found the longitude, by chronometer, to be 49° 7′ west, the variation, by amplitude, at setting was 19° 4′ east. We kept our course until we had run 32 miles; the wind was at S.W., and we hauled up to the S.E. and run 12 miles to avoid a great quantity of ice trending in that direction: the weather cold and very clear. At 3 a.m. [on Thursday, December 6, 1821] the man at the mast-head discovered land and ice, bearing E. by S.: at this time the James Monroe was about four miles a-stern of us; I shortened sail for her, and hailed her; they had not seen it until close up with us, and then Captain Palmer doubted whether it was land or ice; but, at all events, he said he would follow me: we accordingly made sail, and approached the land in as direct a course as we could, for the icebergs were scattered around the land in every direction. At 9 a.m. we were up with the land; it proved to be three spiral rocks quite inaccessible, without the least sign of vegetation.

These, with good reason, Powell called the Inaccessible Isles; and although they were the first landfall to be made in the history of the group, for 111 years there is no record of anyone having set foot on them, until in January 1933 a party landed from the 'Discovery II'.

From the Inaccessible Islands more land was sighted bearing east by north, which they approached with considerable difficulty owing to the ice; but in the early afternoon Powell was near enough to observe that it was "a cluster of islands forming a bight with the eastermost land".[1] The 'Dove' entered the bight followed by the American sloop.

> I told Captain Palmer [Powell writes], that I intended to land in my boat, he said it would not be worth while, for they could see no prospect whatever of any seals; at all events we got our boat out, and proceeded into the bight to a narrow pass that separated the islands from the main land. I here found the tide to be setting to the northward, at about 4 miles per hour, which I found by the shore to be flood tide. At the entrance of this passage the soundings were very irregular, and the bottom rocky: in the centre of it there is a rock with not more than 6 feet water on it. The tide rises about 6 or 8 feet.

There is little doubt that this passage, which appears to have been examined minutely by Powell, is the narrow channel to the east of Spine Island; it passes between Spine Island and the mainland, communicating with Powell's bight in the north and with Sandefjord Bay in the south[2] (Chart I). It was at the northern entrance to this channel (Plate XII, fig. 1, and Chart I) that the first landing ever effected on the group was made, an occasion which is described by Powell in the following passage:

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[1] Powell's bight is evidently the bight to the north of Sandefjord Bay formed by the Larsen Islands with the mainland (see chart in pocket at end).

[2] Here Powell's sailing directions are of more than historical interest, for his is the only description that exists of this particular channel. To the west of Spine Island and dividing Spine Island from Larsen Island, there is a similar although slightly broader channel, now known as the Narrows, through which the tides run very strongly. Whilst surveying the South Orkneys in January 1933, the R.R.S. 'Discovery II' passed through and sounded the Narrows. Powell's passage to the east of Spine Island was "thought to be clear" but unfortunately was not examined.

> At this place we landed, and took possession in the name of King George the Fourth, leaving a bottle, containing a note, stating the particulars of the discovery; and, as I imagined it to be the first land discovered since the coronation of our most gracious sovereign, I have named it Coronation Isle. I observed, on landing, that the sloop James Monroe had got her boat out, and was going on shore at the point of the bight [i.e. at the western point of Larsen Island]; but I afterwards ascertained that they went only to some drift ice, to get a sea-leopard.

Evidently his latter remarks about the 'James Monroe' were added with a view to emphasizing the British claim to the discovery.

> I found here [he continues] an immense number of penguins, Port Egmont or sea-hens, and pigeons, many of which we knocked down with our clubs, they being so very tame. The land is but little clear of snow and ice, for the penguins had not sufficient clear space of land for their nests, there being a great number of them setting on their eggs in the snow. It appeared to me that they had laid their eggs on the surface of the snow, and that, by their sitting on them, the heat from the bird melted the snow around, and caused the bird with its eggs to sink down; some that I took out of these holes, were down as much as two feet below the surface of the snow, and their eggs quite cold; at the same time the birds around them, that had laid their eggs on hard ground, were almost ready to bring forth their young.
>
> I saw no signs of vegetation whatever. I got into my boat, and proceeded [southwards] through the passage until we arrived at a bluff point; from this situation, I had a clear view of the coast, [the southern coast of Coronation Island] which took directly off to the eastward: this point I named Return Point, because I returned directly on board from this. We got on board by 6 p.m.; we were then about half a mile from the westernmost point of the bight. I took sights, and found its longitude, by chronometer, to be 46° 7′ west, and from the result of trigonometric operations, I found the latitude to be 60° 36′ south: this I named Cape Nicholas, as the day answered to that by the Almanack. From this point to the extent of 10 or 12 miles in every direction (where the land did not intervene) were to be observed immense icebergs, drifting about with the wind and tide; some of the largest remained stationary, and were evidently aground, for the tide mark was very plainly to be seen on them: while I was close to one of these icebergs, I sounded with 195 fathoms, and got no bottom: I supposed it to be about 250 or 300 feet above the surface of the sea, and there were two arches completely through the berg, of sufficient height to admit the vessel through: I did not attempt it, from fear that the ice should shelve out under water.

For the next few days the two ships sailed slowly eastward along the north coast of Coronation Island, Powell fixing and naming prominent points on the way. The weather, which was at first bad, either very foggy or blowing, improved considerably on the morning of the 9th. The narrative continues:

> ...we had strong gales of wind from S.W., [throughout the afternoon and evening of December 8] with thick sleet; the weather being so bad I stood off and on shore; the latter part [on the morning of December 9], the weather became more moderate, and we stood close in-shore, while our consort chose to keep outside the icebergs. I found my latitude at noon, by meridian altitude, to be 60° 30′ south, longitude, by chronometer, 45° 28′ west; Conception Point bore W.S.W. about ten miles. I found the iceberg to be aground close in-shore, with about a quarter of a mile clear passage, through which I run the Dove,...at 3½ p.m. [on December 9] we joined our consort, at the entrance of a strait [later called Lewthwaite Strait by Powell], trending in a S.S.E. direction. On opening this strait more clearly, we could discern the appearance of a harbour; we therefore stood into the strait, and hoisted out a boat, in which I went myself, to search if the place would afford us shelter, for the

> weather had every appearance of being bad. I found, on sounding, the place we thought would do, that the bottom was all rocks, and, consequently, unsafe; but we discovered another point that offered better: to this we proceeded, and found a safe and commodious harbour. I sounded it all over, and found from 30 to 14 fathoms, good clay bottom, and capable of containing a number of vessels. Here you may be sheltered from all winds; for the most part the harbour is composed of perpendicular icebergs. At about nine or ten yards from high-water-mark, the beach, under these icebergs, is mostly of sand: this I named Spence's Harbour, and having found it a safe one, I returned to the vessel. The James Monroe being in-shore of the Dove, I had to pass her, and told Captain Palmer to proceed in, for the harbour was perfectly safe: the vessels were now under the high land, and had lost all the wind; we therefore found it requisite to tow them into the harbour. At 5 p.m. we anchored in 14 fathoms water, clay bottom. The middle and latter part of these twenty-four hours, we had hard gales and thick snow; the wind we could perceive, by the clouds, to be S.W.; but where we lay at anchor, the flaws set down in all directions, owing to the high land that surrounded us; the icebergs fell a great deal, but did not incommode us at our anchorage.

By the evening of the 9th, then, both vessels having successfully coasted the northern side of Coronation Island, with the approach of bad weather had found shelter on the western side of Lewthwaite Strait in what appears to have been a commodious and admirably situated harbour. To the few who are acquainted with the South Orkneys, Powell's description of Spence's Harbour may sound a somewhat generous one. At all events, more than eighty years after its discovery, the 'Scotia', while searching for a haven in which to pass the winter in 1903, found it to be "ridiculously exposed, with very deep water".[1] We must bear in mind, however, that Powell's description was written more than a hundred years ago and in that time considerable alteration may have been wrought in the shape and even the depth of the harbour through changes in the position, or breaking up of the ice-cliffs with which it once seems to have been almost encompassed. Dumont D'Urville, who visited the group in 1838, appears to have been strongly attracted by this possibility and remarks on it at some length.

> Il est encore indubitable [he writes] que le degré plus ou moins avancé de la fonte générale des glaces doit faire subir aux accidents de la côte des modifications sans nombre. Ainsi, tout tracé du littoral opéré sur ces terres, tant qu'elles sont encore ensevelies sous les neiges, ne peut être définitif et ne sera relatif qu'à l'époque même où il aura été exécuté. C'est à ce motif que j'attribuai dès-lors les différences surprenantes que je remarquais entre les formes des terres indiquées sur la carte grossière de Weddell et celles qui se représentaient à mes regards.[2]

In seeking for a further explanation of the obvious change that has taken place in the character of Spence's Harbour we should not perhaps disregard altogether the fact that the South Orkneys are notoriously infested by barrier icebergs, and that the presence of such obstacles lying stranded across the entrance of an otherwise exposed bay, would considerably enhance its attraction as an anchorage.

From Powell's narrative of the easterly passage along the north coast of Coronation Island, it is fairly obvious that it was Palmer who was actually the first to sight Lewthwaite Strait. It is apparent that on the morning of December 9 the two vessels separated, Palmer keeping at some distance from the land while Powell with considerable daring stood close inshore, the better to chart the coast-line and search it minutely for seals. As the 'Dove' was following a longer and more intricate course than the 'James Monroe' the latter no doubt would be inclined to draw ahead and indeed it is abundantly clear, I think, from Powell's remark, "we joined our consort, at the entrance of a strait", that when he did eventually arrive off the northern entrance to Lewthwaite Strait at half-past three in the afternoon, Palmer was already there to greet him.

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[1] Mossman, R. C., 1906, *The Voyage of the 'Scotia'*, p. 69 (Edinburgh and London).

[2] D'Urville, D., 1842, *Voyage au Pôle Sud, Histoire du Voyage*, 2, p. 70 (Paris).

It is thus fairly certain that Palmer was the discoverer of Lewthwaite Strait, and although at first sight this may appear to be a rather trivial matter it is nevertheless of some historical importance. More than a decade after their discovery an extraordinary account of this first journey to the South Orkneys was published by Fanning in America (see pp. 299 *et seq.*), a story which although reputed to come from Palmer is nevertheless so divorced from the actual facts that in many quarters it has caused grave doubts to be cast on Palmer's veracity. As we shall see later, however, the probability of the American discovery of Lewthwaite Strait leads us now to suspect that whatever the truth of Palmer's story as a whole, at least part of it had a substantial foundation in fact (see p. 302). In the meantime we must return to Powell's narrative.

In Spence's Harbour the vessels lay for nearly three days. On December 11, three boats were despatched, two from the 'Dove' under the chief officer, and one from the 'James Monroe'. The American boat went southwards through Lewthwaite Strait as far as its south-westernmost point, but finding no fur seals returned shortly afterwards to the 'James Monroe', bringing four or five Weddell seals or "Sea Leopards", the name by which the Weddell seal was then known. The British boats, which returned later in the day, had gone to the eastward and having discovered and passed across Washington Strait, had examined the western end of Laurie Island. They too were unsuccessful in their search for fur seals, returning with only eleven Weddell skins. Powell records that they found two very good harbours but he does not say what or where they were. One of them is almost certainly the Ellefsen's Harbour[1] which appears in his chart (Fig. 2) and is now regarded as one of the best harbours in the group.

Being now short of provisions Powell, on the afternoon of the 12th, was reluctantly compelled to give up his further examination of the islands. Passing through Lewthwaite Strait, he stood due south through vast quantities of icebergs until he was held up by heavy pack-ice in latitude 62° 20′ S. He turned westward along its edge and eventually sighted Clarence Island again at noon on the 16th.

Powell does not say whether Palmer accompanied him on his return journey to the South Shetlands. Bruce,[2] although he had not seen it stated, assumes that he did, while

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[1] It should perhaps be pointed out here that this name, which, when employed, has appeared as "Ellessen Harbour" in all the published charts of the group since 1839, with the exception of L. Friederichsen's *Originalkarte des Dirck Gherritz-Archipels, Hamburg*, 1895, was originally engraved in Powell's first chart as "Ellefsen's Harbour", with a long f and not an old-fashioned long s. Unless the engraver was at fault this would appear to be the correct name.

[2] Bruce, W. S., 1917, *The Weddell Sea: An Historical Retrospect*, Scott. Geog. Mag., XXXIII, p. 249.

Balch[1] states definitely that both Powell and Palmer returned to the South Shetlands together, arriving at Clothier's Harbour on the north coast of Roberts Island on December 22. On the other hand, as there is no evidence either in support of Bruce's assumption or Balch's assertion, it may equally be held that Palmer was left behind at the South Orkneys and that he found his own way back to the South Shetlands. From his journal Powell, certainly, had arrived at Clothier's Harbour on December 22, but it may have been much later before Palmer returned from the east. It is evident, at least, that he was at the South Shetlands some time before the end of January (although how long before we do not know) from the following letter to him from Benjamin Pendleton dated "Shetland, Jany 25, 1822", and beginning "You being ready you will proceed to sea & make all possible dispatch for the port of Stonington...".[2] Fanning,[3] too, if any reliance can be placed on his dates, would seem to imply that this easterly journey to the South Orkneys, at least as far as Palmer was concerned, extended into January.

Although Palmer has left no record of the voyage which has just been described, a very vague account of it was published by Edmund Fanning,[3] which for lack of further evidence must be ascribed in whole or in part to Palmer.

According to Fanning Palmer at the beginning of the season 1821–2 had been detached in the sloop 'James Monroe' from the main Stonington fleet (then operating at the South Shetlands under Benjamin Pendleton) in order to follow up and extend the exploration of that part of the coast[4] to the south-west of the Bransfield Strait which he had seen the previous season when in command of the 'Hero'. Fanning goes on to describe how Palmer crossed the Bransfield Strait and followed the coast of "Palmer's Land" to the eastward during the months of December and January:

> In this way he coasted along this continent upwards of fifteen degrees, viz. from 64 and odd, down below the 49th of west longitude. The coast, as he proceeded to the eastward, became more clear of ice, so that he was able to trace the shore better; in 61° 41′ south latitude, a strait was discovered, which he named Washington Strait, this he entered, and about a league within, came to a fine bay which he named Monroe Bay, at the head of this was a good harbor; here they anchored, calling it Palmer's Harbor. The Captain landed on the beach among a number of those beautiful amphibious animals, the spotted glossy-looking sea leopard, and that rich golden colored noble bird, the king penguin.

It is obvious of course that the strait which Fanning mentions was Washington, or even more probably Lewthwaite, Strait in the South Orkneys,[5] for no other land exists near the latitude 61° 41′ S "below the 49th of west longitude". It is equally obvious that part of this journey at least must have been that which Palmer undertook in company with George Powell from Elephant Island. The position of Palmer's Monroe Bay is uncertain. Bruce[6] thinks it might be Wilton Bay at the western end of Laurie Island, but it might very well be Spence's Harbour on the east side of Coronation Island, where as has already been stated (pp. 297–8) both the 'James Monroe' and the 'Dove' lay for nearly three days. It should be observed, moreover, that Spence's Harbour is in Lewthwaite Strait, which as far as we can judge was actually discovered by Palmer.

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[1] Balch, E. S., 1902, *Antarctica*, p. 97 (Philadelphia).

[2] Balch, E. S., 1909, *Stonington Antarctic Explorers*, Bull. Amer. Geog. Soc., XLI, p. 483.

[3] Fanning, E., 1834, *Voyages Round the World*, pp. 438–40 (London).

[4] "Palmer's Land."

[5] A fact recognized by D'Urville as early as 1842 in *Voyage au Pôle Sud, Histoire du Voyage*, 2, p. 16 (Paris).

[6] Bruce, W. S., 1917, *loc. cit., supra*, p. 249.

Edmund Fanning has written such an extraordinary account of Palmer's easterly journey to the South Orkneys that one is tempted to enquire whether it originated entirely with Palmer or in Fanning's rather fertile imagination. The ultimate responsibility, of course, rests with Palmer, who like the majority of the sealers of his day appears to have kept a most inadequate journal,[1] if indeed he kept one at all—an unfortunate circumstance which has helped in no small degree to throw the early history of this region into confusion. Palmer's personal report of this voyage was therefore in all probability purely a verbal one: first to Pendleton at the South Shetlands, and later on his return to America[2] to Fanning, who along with Pendleton was one of the agents[3] for the Stonington fleet. Even if Palmer had produced documentary evidence it was most probably destroyed, as Balch suggests,[4] along with other Palmer records in the fire which burnt down the house of A. S. Palmer, a brother of N. B. Palmer, in Stonington, on November 15, 1850. In the absence of such evidence it is difficult to decide whether to doubt the veracity of Palmer or that of his narrator.

The most that can be said is that Fanning's account is so lacking in precision that it is perhaps unfair to attribute it entirely to Palmer, who by all accounts was a good navigator. It is difficult to believe, as Mill[5] suggests, that he was so grossly misled as to mistake the edge of the pack-ice for the "mainland" over such an immense distance as is implied in Fanning's narrative. Mill writes:

> If Palmer followed the coast to 49° W. he followed it into what is certainly open sea, and if he found a harbour in 61° 41′ S. it could be in no known land. Fanning apparently suggests that Palmer's harbour lay in 49° W., which is far to the east of any land except the South Orkneys; and from Powell's map there is no doubt that what Palmer followed was the edge of the pack which that season stretched unbroken to the South Orkneys where the strait he threaded and the harbour in which he anchored are duly charted.

There is no evidence either in Powell's journal or in his chart that the easterly track of the 'Dove' from Elephant Island (Fig. 1)—and therefore that of the 'James Monroe'—lay within sight of such a large body of pack to the southward. If any pack was encountered at all, and it may be supposed there was from Powell's remark "a great quantity of ice trending in that direction", it was probably an isolated patch or detached stream, which however lay to the *north* of the 'Dove's' track, since she had to haul up to the south-east to avoid it. Actually, as Powell's chart shows, the main mass of the pack lay out of sight and a long way to the southward. But even if an unbroken line of ice had lain to the southward and within sight of his track we have not the slightest reason for supposing that Palmer was incapable of distinguishing it from land. On the contrary it can hardly be doubted that he had more than a passing acquaintance with ice and ice forms; for when his attention was first drawn to the new land ahead, girt about as it was with icebergs, it is recorded that "Captain Palmer doubted whether it was land or ice", which while implying that he was perhaps reserved and cautious in his judgment, perhaps reluctant to jump swiftly to conclusions, suggests above all that he was already aware, as every sailor who has visited the Antarctic is aware, how easy it sometimes is at a distance to mistake icebergs for islands.

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[1] At any rate in the 'James Monroe'. He seems to have kept a log of sorts in the 'Hero' but his authority, Balch (*Stonington Antarctic Explorers*, p. 477), is not at all clear about it.

[2] Shortly after the middle of June, 1822, *vide Stonington Antarctic Explorers*, p. 474.

[3] Balch, E. S., 1909, *Stonington Antarctic Explorers*, Bull. Amer. Geog. Soc., XLI, p. 483.

[4] *Ibid.*, p. 473.

[5] Mill, H. R., 1905, *The Siege of the South Pole*, p. 103 (London).

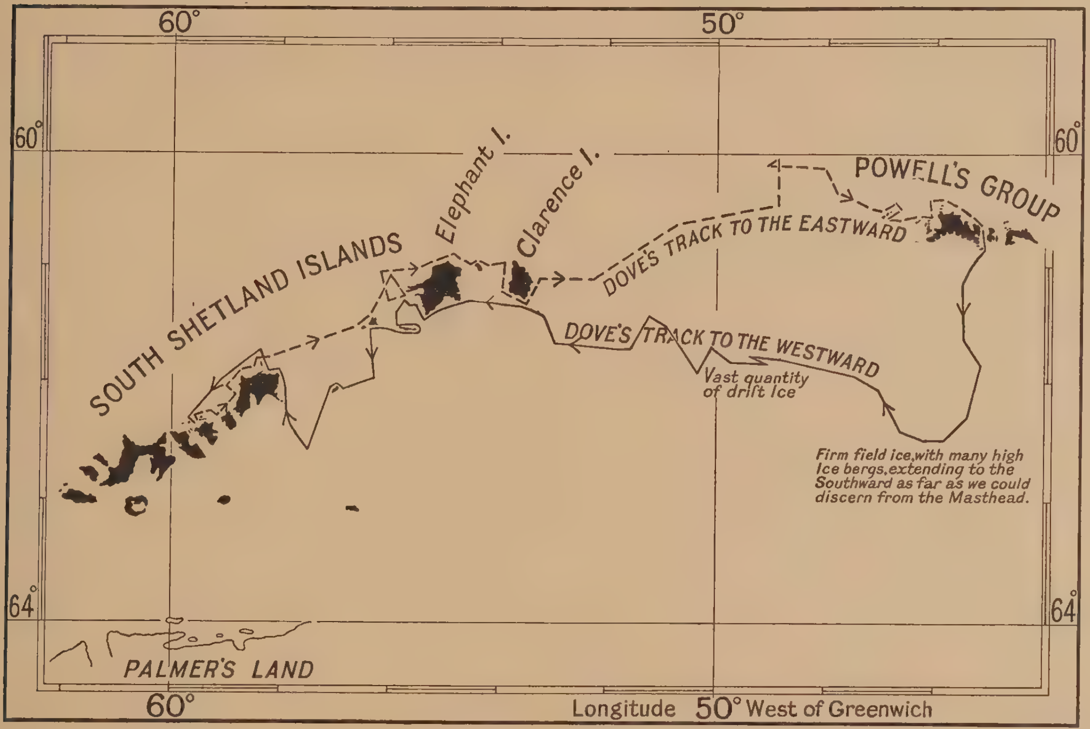
60°
50°
60°
60°
Elephant I.
Clarence I.
POWELL'S GROUP
SOUTH SHETLAND ISLANDS
DOVE'S TRACK TO THE EASTWARD
DOVE'S TRACK TO THE WESTWARD
Vast quantity of drift Ice
Firm field ice, with many high Ice bergs, extending to the Southward as far as we could discern from the Masthead.
64°
64°
PALMER'S LAND
60°
Longitude 50° West of Greenwich

Fig. 1. Track of the 'Dove' to and from the South Orkneys: taken from *Chart of South Shetland*, published by R. H. Laurie in November, 1822.

It is easier to suppose that he was misled as to the easterly extension of "Palmer's Land" before his meeting with Powell at Elephant Island on November 30; that having sailed along and beyond the coast of "Palmer's Land" until he came to, say, D'Urville Island, he crossed from there to the Elephant-Clarence group, and in the thick weather which frequently prevails in this region during the summer months, failed to realize that he had lost touch with the "mainland". Had heavy pack-ice then lain across the eastern end of the Bransfield Strait, as it frequently does in November, in the general uncertainty of the fog he might possibly have regarded that as continental, or rather imagined it to have some close association with the supposed continent he had just left.

There are good grounds for believing that at least part of Palmer's story, that relating to the discovery of Washington Strait, may have been correctly told; for as we have already seen he actually does seem to have been the first to sight Lewthwaite Strait, a fact he would naturally recount with some emphasis and pride to Fanning in describing his personal share in the exploration of the South Orkneys. Indeed it is not at all unlikely that he may have named the Strait he seems to have discovered after the first American president. He may have been quite unaware that Powell had already called it after his friend and teacher, Lewthwaite of Rotherhithe, or perhaps Palmer, or rather Fanning, somehow or other got it mixed up with the real Washington Strait to the eastward. It is difficult to say, for it is not clear from Powell's journal which of the two sealers, himself or Palmer, was responsible for the application of the American name to the eastern strait. If it was not Palmer, it is quite certain that Powell employed it out of courtesy to Palmer, and if this is so it is rather curious that he should have applied it to the eastern passage which was so obviously discovered by the British boats and not to the western, which was apparently, although not so obviously, discovered by the Americans. Whether Powell was responsible for the name or whether Palmer, whether the confusion that would seem to have arisen in America as to its precise application was due to Powell, Palmer or Fanning, or to all three, are purely speculative questions and of no very great importance. What is of importance is this: Palmer's claim to have discovered *a* particular strait somewhere in the vicinity of the South Orkneys should not be lightly disregarded merely on the grounds of Fanning's bewildering account, for in view of the actual facts which we have seen it would appear to have considerable justification.

On these grounds we may therefore argue that the responsibility for the gross inaccuracy of this account rests with Fanning rather than with Palmer, and that Palmer's personal report, although in a measure inaccurate, was distorted to such an extent by Fanning as to become almost unrecognizable.

Having presented Fanning's story in the light of the actual facts which are revealed in Powell's journal, and shown that through Fanning at least a partial injustice has been done to Palmer, we may return now to the discussion begun on p. 293 and consider in some detail what land, if any at all, Palmer discovered, or believed he discovered, before his meeting with Powell at Elephant Island on November 30, 1821. In the first place it is rather unlikely that he believed that the present Trinity Peninsula stretched unbroken by sea to Elephant Island, for he must have been as aware as Powell was of the insularity of the latter since both sealers had examined it thoroughly, together with the adjoining Clarence Island, in their search for seals. That he may have been misled into believing that the Trinity Peninsula extended for some distance in the direction of Elephant Island is not so unlikely, for Bransfield himself, the first explorer of this region, was misled in precisely the same manner while passing from D'Urville Island towards Elephant Island in thick fog during the first few days of February 1820. Whatever Palmer may have believed it is extremely likely that he followed a course very similar to that of Bransfield, who, skirting the Trinity Peninsula more than a year before him, had sighted and charted its northern coast at two points, viz., "Trinity Land" in 60° W, and its north-eastern extremity in the neighbourhood of Mount Bransfield together with the western side of D'Urville Island, in about 57° W. Bransfield's discoveries and approximate track along the Trinity Peninsula and thence to Elephant Island are admirably shown in the map which accompanies Gould's paper *The First Sighting of the Antarctic Continent*, and with these earlier discoveries in view it is possible now to arrive at a reasonable estimate of the nature and extent of the land which Palmer might have discovered in the late spring of 1821 during his second voyage of exploration in the 'James Monroe'. If, as Fanning relates, he came up with the coast of "Palmer's Land" in the 64th meridian and turned eastward, or more correctly north-eastward, he undoubtedly discovered in turn Anvers, Brabant, and Liège Islands—the Palmer Archipelago—with which, however, he appears to have been already partially acquainted from his previous voyage in the 'Hero'. Then, having skirted Bransfield's "Trinity Land" and provided (which is quite uncertain) that he had the land always in sight all the way to D'Urville Island, he can scarcely have failed to discover that part of the north coast of Trinity Peninsula, between 59° 45′ and 57° 45′ W, in length some fifty-five miles, which Bransfield lost sight of in fog on January 30 or 31, 1820, but which he indicated on his chart with a pecked line and the legend "Supposed Land".

Finally, it should be noted that Palmer made this voyage of discovery in November 1821 and not in December and January 1821–2 as Fanning states, for as we have already seen he was at Elephant Island on November 30 and his movements since then, so far as they can now be ascertained, have been accounted for up to January 25, 1822, when he presumably sailed for America (see p. 299). Now, as the southern and especially the south-eastern coasts of the Bransfield Strait are often beset for a long way to the north by pack-ice in November, besides being fog-bound, the probability that Palmer discovered or saw large tracts of the coast of Graham Land in the 'James Monroe' must be considerably diminished. The Palmer Archipelago may, it is true, have been clear of ice, or clear enough for a distant view, but as far as the coast of Trinity Peninsula is concerned, unless he was exceptionally lucky he may quite easily have failed to see the land altogether, or, as is suggested in the editorial preface to Powell's journal, only have seen it from a great distance.

That Palmer cannot have been wholly aware of what actually took place in November and December 1821 is not to be doubted, for evidence exists which clearly proves that some twelve years before the publication of Fanning's book Palmer had made statements in America regarding the discovery of the South Orkneys which correspond in one very important detail with Fanning's account.

In the editorial preface to Powell's *Notes on South-Shetland* it appears that a *New Chart of the Southern Ocean*, together with a Memoir[1] of considerable length dealing with the earliest history of discovery in the South Shetlands, was published by R. H. Laurie in 1822, prior to the publication of Powell's *Chart of South Shetland, including Coronation*

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[1] It is a pity that neither the Memoir nor the New Chart can now be traced. The Memoir, in particular, appears to contain much that would help to clear up the very early history of the South Shetlands.

Island, and his *Notes*. The editor makes acknowledgment to this Memoir in the following passage:

> In pages 194 and 195 are given the results of an exploration by Mr Edward Bransfield, (not Barnsfield,) and a note on the land therein called South-Iceland, from the information of Captain N. B. Palmer, an American, of Connecticut. The latter is inaccurate, as will be seen from the following extracts;...The South-Iceland of the James Monroe, is the Powell's Group of the Dove: it is situate, not in the latitude 61° 41′, as stated in the newspapers, but in 60° 40′, as shown by the New Chart, and was first discovered and explored by the Dove, as hereafter described.

Thus it appears that Palmer's version of the discovery of the South Orkneys had found its way into the English Press in 1822, and had been published by R. H. Laurie some time before Powell himself came home with the true account of the discovery. This is quite possible, for as has already been stated Palmer probably arrived in America from the South Shetlands before the end of June 1822, whereas Powell according to Bruce did not get back to London until August 26 or about two months later.[1] Unfortunately it is not stated to what extent Palmer's information regarding his South Iceland was inaccurate,[2] but it is at least significant that the latitude assigned to it in the Press, 61° 41′ S, is that which appears in Fanning's book for Palmer's Washington Strait, some twelve years later.

Through the kindness of Lieutenant-Commander R. T. Gould I was able recently to examine a chart entitled *Chart of South Shetland, an archipelago discovered by Mr. Wm. Smith in the brig 'Williams', February* 1819, published by R. H. Laurie, 53 Fleet Street, London, on October 22, 1828. It is reduced from Powell's larger chart of November 1822 but embodies a good deal of additional matter based on information from the sealers who came after him. Although the South Orkneys do not appear in it in the bottom right-hand corner there is an interesting legend in which R. H. Laurie again champions Powell as the discoverer of that group and again directs attention to the erroneous lattitude (61° 41′ S) that was evidently still assigned to it in certain quarters. The legend runs: Powell's Group, *otherwise called* South Orkney, *lies in the parallel of* 60.° 40.′ (*not* 61.° 41′) *and between the meridians of* 44.° *and* 47.° *This group was discovered by Captain Powell, in* 1821, *and his chart of it, with the whole of* South-Shetland, *is now published by the Proprietor of this work.*

It may be remarked in conclusion that although Dumont D'Urville, as early as 1842, was fully aware that Fanning's account was largely a fabrication, in recent years Balch and Otto Nordenskjöld in writing about Palmer's much-discussed geographical achievement on the southern side of the Bransfield Strait are both inclined to employ it incautiously and without apparently subjecting it to adequate scrutiny.

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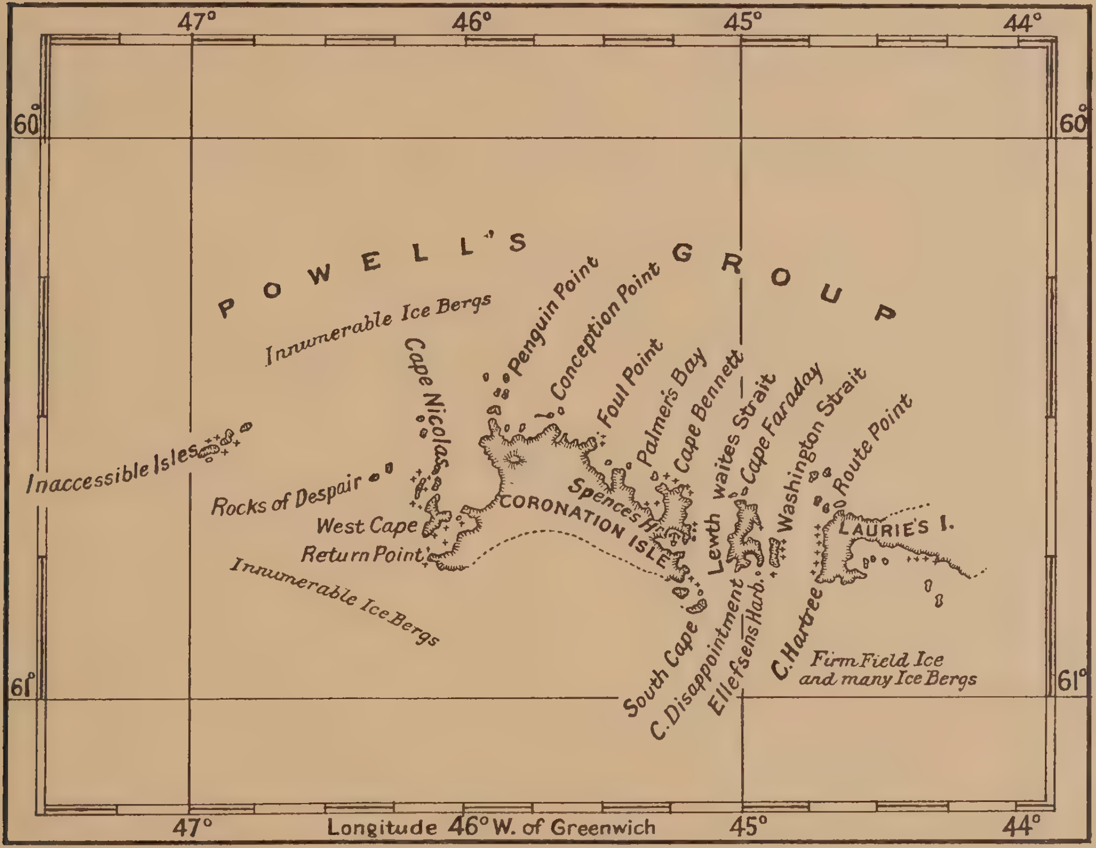
[1] Bruce, W. S., 1917, *loc. cit.*, p. 251.

[2] Some idea of the southerly extent of South Iceland as then laid down in the charts of the South Atlantic is conveyed in the following passage from Weddell (*A Voyage towards the South Pole*, p. 47): "Our latitude by observation being 63° 21′, and longitude by chronometers 45° 22′, we were in a situation to have seen what is represented on the South Atlantic chart in common use, as South Iceland, but, alas! no such place exists."

THE FIRST CHART OF THE SOUTH ORKNEYS

It has already been mentioned (p. 289, footnote) that Powell's chart of the South Orkneys (Fig. 2) was included as part of his general chart of South Shetlands in which the South Orkneys appear under their original name of "Powell's Group".

It is not absolutely clear that Powell was responsible for this name, although as author of the chart he may be assumed to be. Balch,[1] however, states definitely that Powell said to Palmer on the occasion of the discovery: "You have given a land your name, let this land bear mine".[2] On the other hand, since Powell does not allude to the group by any collective title in his journal, and because the islands are referred to as "the Powell's Group of the Dove" only in the editorial preface, it is suggested that the original name was given by R. H. Laurie, who apparently published the chart during Powell's absence (see footnote 2, p. 288). Whichever is the correct view is not of very much consequence now, for Weddell (see p. 309), who landed on the islands some nine weeks



47°
46°
45°
44°
60°
61°
POWELL'S GROUP
Innumerable Ice Bergs
Inaccessible Isles
Rocks of Despair
West Cape
Return Point
Innumerable Ice Bergs
Cape Nicolas
Penguin Point
Conception Point
Foul Point
Palmer's Bay
Cape Bennett
Spences Hr.
CORONATION ISLE
South Cape
C. Disappointment
Lewth waites Strait
Cape Faraday
Ellefsens Harb.
Washington Strait
C. Hartree
Route Point
LAURIE'S I.
Firm Field Ice and many Ice Bergs
Longitude 46° W. of Greenwich

Fig. 2. Powell's chart: taken from *Chart of South Shetland*, published by R. H. Laurie in November, 1822.

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[1] Balch, E. S., 1904, *Antarctica Addenda*, Journ. Franklin Inst., CLVII, p. 86 (Philadelphia).

[2] However this may be, it apparently did not deter Palmer from calling the new discovery South Iceland.

after Powell's discovery, called them the South Orkneys, the name which is now adopted in preference to the original and has appeared on the British Admiralty charts of the group since 1839.

In view of the antiquity of Weddell's name, and because it is so obviously appropriate as a companion name to that of the South Shetlands, and perhaps because Powell did not after all give his own name to the group, the efforts of Balch[1] and Otto Nordenskjöld[2] to restore the original "Powell's Group" to the charts are rather unnecessary, and indeed, in Nordenskjöld's case, apt to be confusing.[3] There is little injustice to Powell in retaining the name South Orkneys, for the Admiralty charts all bear a note against this title fully acknowledging Powell's discovery, and besides, Powell's name has been applied to the middle and third largest member of the group since 1839. Finally, as Weddell gave the name South Orkneys to the group without knowing that it had already been discovered, he cannot be said to have deliberately or carelessly displaced an original name.

Powell's chart is of course incomplete as he did not visit the southern side of Coronation Island, nor was he able to determine the eastern extent of Laurie Island. At an early date, however, his positions appear to have been regarded as more accurate than those of Weddell (see p. 310), although of the two explorers Powell was probably the less suitably provided with instruments. Thus Purdy[4] in 1845 says: "By observations made on the 14th [by Weddell], it appeared that Saddle Isle, one of the easternmost islets of the group, lies in latitude 60° 37′ 50″, and longitude, by mean of 3 chronometers, 44° 52′ 45″. Mr Powell placed this isle in 60° 36′ S, and 44° 32′ W, and this, we conjecture, is nearest to the truth." Purdy makes a curious error here, for Powell was not aware of the existence of Saddle Island, which was discovered and first charted by Weddell in January 1823 and thus does not appear in Powell's chart of 1822. A second edition of Powell's chart was published in 1831 revised and corrected by Fildes, and it must be this to which Purdy refers (see p. 312 and Fig. 5).

JAMES WEDDELL

Powell and Palmer were not apparently the only sealers for whom hunting had gone badly and who were seeking fresh fields this summer of 1821–2. At least forty-four British and American vessels were then engaged at the South Shetlands and one of these, the cutter 'Beaufoy' of London, in December 1821 sailed eastwards from Elephant Island into the Weddell Sea. From a great distance (at least sixty miles) she sighted the western end of Coronation Island some time before noon on December 12, that is, only six days after the actual discovery of the group by Powell. The 'Beaufoy' thereafter returned to the South Shetlands. No written record of this voyage exists and our only authority for it is Weddell's track chart facing p. 1 of his book *A Voyage towards the South Pole*, in which a track entitled *Beaufoy in December* 1821 is shown (Fig. 3), together with the legend against the date December 12 "*saw the land*". The distance at which this landfall was made, although great, is not improbable, for Yalour[1] in writing of the northerly approach to the islands states that in clear weather the South Orkneys can be seen sixty miles away. Moreover, on February 23, 1838, D'Urville[2] records that he sighted the South Orkneys from a position not so very far from that of the 'Beaufoy' on December 12, 1821, as he was passing from the western end of Coronation Island towards Clarence Island: "Entre sept & huit heures nous relevons encore les îles Orkney aux bornes de l'horizon presqu'à vingt lieues de distance."

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[1] Balch, E. S., 1912, *Antarctic Names*, Bull. Amer. Geog. Soc., XLIV, No. 8, p. 570.

[2] Nordenskjöld, O., 1911, *Die Schwedische Südpolar-Expedition und ihre Geographische Tätigkeit*, I, Lief. I, p. 70 (Stockholm).

[3] Nordenskjöld's suggestion was that the name Powell Group should be applied to Elephant and Clarence Islands.

[4] Purdy, John, 1845, *The New Sailing Directory for the Ethiopic or Southern Atlantic Ocean*, 3rd ed., Section I, p. 155 (R. H. Laurie, London).

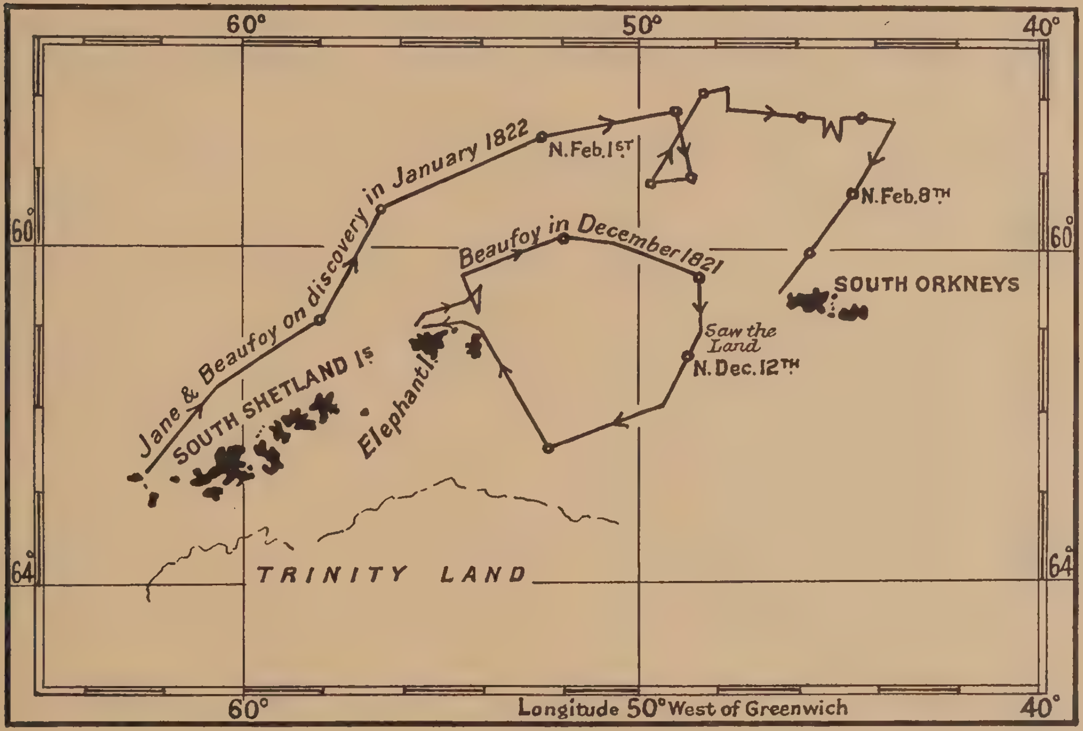

Fig. 3. Macleod's and Weddell's tracks in December, January and February, 1821–2: taken from Weddell's track chart in *A Voyage towards the South Pole*.

This second sighting of the South Orkneys, following so close on their discovery by Powell, is generally ascribed nowadays to Weddell, who was then at the South Shetlands on his second southern voyage. Bruce[3] writes: "Weddell, definitely, in December 1821, cruised into the north-western corner of the Weddell Sea in the cutter *Beaufoy* of London, almost synchronously with Powell and N. B. Palmer, but scarcely so far east, and almost simultaneously discovered the South Orkneys." Recent investigation, however, kindly undertaken for the author by Captain J. B. Harrold, O.B.E., R.N.R., the Registrar-General of Shipping and Seamen, has shown that the master of the 'Beaufoy' was then one Michael McLeod, a hitherto unknown sealer, to whom in view of the evidence which will now be put forward the honour of this independent discovery of the group must be given.

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[1] Yalour, J., *En el última viaje de la Uruguay á las regiones polares*, Bol. Inst. Geog. Argentina, XXII, p. 34.

[2] D'Urville, D., 1842, *Voyage au Pôle Sud, Histoire du Voyage*, 2, p. 137 (Paris).

[3] Bruce, W. S., 1917, *loc. cit., supra*, p. 243.

It is well known from his book *A Voyage towards the South Pole* that James Weddell was in supreme command of the brig 'Jane' of Leith and the cutter 'Beaufoy' of London during his great southern voyage of September 1822 to July 1824. Prior to September 1822, that is during his first and second southern voyages which took place between 1819 and 1822, his connection with the 'Beaufoy' is not so clear, nor is there in his book any convincing evidence in support of such a connection, although it is now known to exist. One important fact is clear, however, and it is this: Weddell's vessel appears always to have been the 'Jane', there being no evidence that during the period with which we are concerned he was ever in personal command of the 'Beaufoy', a fact which seems to be confirmed by the records in the office of the Registrar-General which are given here:

'Jane'		'Beaufoy'	
Master	Period of command	Master	Period of command
James Weddell	1819 (possibly before) to 1822	William Hadgraft	May 1, 1819 to June 29, 1821
,,	1822 to August 18, 1824	Michael McLeod	June 29, 1821 to September 7, 1822
,,	June 19, 1827 to November 7, 1827	Matthew Brisbane	September 7, 1822 to July 10, 1826
,,	February 7, 1828 to June 1829		

Weddell could not therefore have made this independent discovery of the South Orkneys unless having a certain business connection with her, in which he was McLeod's superior, he had transferred himself to the 'Beaufoy' in December 1821. That such a connection did exist has now been clearly demonstrated owing to the kindness of Captain Harrold, although, it should be observed, there is no evidence that Weddell ever transferred himself to the 'Beaufoy' in the manner which has been suggested. From the records at Tower Hill it would appear that James Weddell of Burr Street, Smithfield, Middlesex, and John Strachan of Edinburgh were owners of the 'Beaufoy' from 1821 to 1828 but that Weddell did not become part owner of the 'Jane' until 1824, when he held twenty-one shares in her along with the aforementioned John Strachan and James Mitchell of London with twenty-two and twenty-one shares respectively.

It has already been mentioned that the evidence in Weddell's book in support of his early connection with the 'Beaufoy' lacks conviction, and indeed such evidence as does exist both there and elsewhere is rather conflicting. Of Weddell's first and second voyages no account exists other than the frequent references he makes to them in his book, but nothing that he says there suggests that any ship other than the 'Jane' was then under his command. Moreover his biographer, Laughton,[1] states that he used the 'Jane' only on these voyages, and infers that his first association with the 'Beaufoy' dates from September 1822, while certain early Weddell manuscripts and letters which Laughton seems to have used, now in the possession of the Royal Scottish Geographical Society, likewise contain no reference to the 'Beaufoy' in connection with his voyages prior to September 1822. The only evidence of any connection at all is again furnished by Weddell's track chart, in which there appears, in addition to McLeod's track in the 'Beaufoy' above, another track entitled *Jane & Beaufoy on discovery in January* 1822 (Fig. 3); but here Weddell appears to contradict directly the evidence of his own track chart, for this track leads eventually to the South Orkneys where a landing was made on or about February 10, 1822, of which Weddell writes, "but having a loaded ship, and no second vessel, I was obliged to relinquish a deliberate examination of their shores for that season".[2] The 'Beaufoy', however, may have parted company with him before he reached the South Orkneys.

McLeod, as we now know, must have been responsible to Weddell in his capacity as part owner of the 'Beaufoy'; and in these circumstances what would appear to have happened is that McLeod either on his own initiative or under orders from Weddell, and presumably in search of fur seal, sailed eastwards from Elephant Island, and having sighted what he took to be new land, returned to the South Shetlands where he met Weddell and informed him of his discovery. Later, about January 29, 1822, the 'Jane' accompanied by the 'Beaufoy' left the western end of the South Shetlands in order to investigate further the land which McLeod had seen. Of the two vessels the 'Jane' at least made the land, and Weddell having landed on February 10 called it the South Orkneys.

From this, his second southern voyage, Weddell returned to England on July 12, 1822, and reported what he seems to have regarded as his discovery of the South Orkneys to the Commissioners of His Majesty's Navy.[3] Powell, on the other hand, did not arrive in London until August 26 and he reported his discovery to R. H. Laurie who did not publish his chart until November 1. In the meantime (on September 17) Weddell had sailed again in the 'Jane' on his third and greatest Antarctic voyage accompanied by the 'Beaufoy' under Matthew Brisbane. He sailed some six weeks before the publication of Powell's chart, and apparently still unaware of Powell's previous discovery of the group.

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[1] Laughton, J. K., 1889, *James Weddell*, Dictionary of National Biography, LX (London). Laughton telescopes his first and second voyages into one and says he made such a success of it that he was able to buy a share in the 'Jane' for his second and greatest voyage along with the 'Beaufoy' in 1822–4.

[2] Weddell, J., 1825, *A Voyage towards the South Pole*, 1st ed., p. 21 (London). As far as can be seen from Weddell's track chart this landing appears to have been made somewhere near the north-western corner of Coronation Island.

[3] I cannot, however, be certain that he claimed the South Orkneys as his own discovery: his official report to the Admiralty is recorded merely in a footnote on p. 20 of his book: "Reported by me to the Commissioners of His Majesty's Navy, on my arrival in England, in 1822." I have been unable to trace the present whereabouts of this report.

Thus in 1822 three conflicting reports came to London of the discovery of this new land: first (probably) Palmer's vague story of "South Iceland" situated in 61° 41′ S; then Weddell's report to the Admiralty; and finally Powell's reliable account to R. H. Laurie.

In the beginning of 1823 Weddell again visited the South Orkneys[1] in search of fur seal and doubtless also in order to make further geographical acquaintance with a new land to which he had paid only the briefest visit in 1822. He sighted the eastern end of Laurie Island on January 12 and on the afternoon of the 15th landed on Saddle Island, thus named by Weddell from its peculiar shape. Thence his vessels went westwards examining the northern coast of Coronation Island and were off West Cape, the south-western corner of Coronation Island, on the 20th. They returned by the same route and on the 22nd reached the most easterly point of Laurie Island which Weddell named Cape Dundas "in honour of the illustrious family of that name". Here a landing was made. In the meantime the southern shores of the group had been examined and very roughly charted by the ships' boats under Matthew Brisbane. His search of the group having been rewarded by only three fur seal, Weddell now stood southwards from Cape Dundas, his immediate path lying through a chain of icebergs set so closely together that they were thought from a distance to be a range of land.

Beyond saying that they were "if possible, more terrific in appearance than South Shetland", Weddell has given little description of these islands; but his general impression of this "cold earthless land, and its immense ice islands" is perhaps particularly applicable to the South Orkneys: "The part of the country which I have seen is without soil, reared in columns of impenetrable rock, inclosing and producing large masses of ice, even in the low latitude of 60° 45′."[2]

The first Weddell seal ever taken from the Antarctic was collected by Weddell at the South Orkneys (probably from Saddle Island) and sent to the Royal Scottish Museum in Edinburgh, where stuffed in a grotesque shape it was for long on exhibition in the public galleries.[3] At Cape Dundas he says there was a patch of short grass, the only flowering plant ever recorded from the South Orkneys, but in spite of careful search no trace of it has been found in recent years (see p. 367).

WEDDELL'S CHART

Weddell's chart of the South Orkneys (Fig. 4) appears only in his book *A Voyage towards the South Pole* where it occupies a single octavo page; it was not published as a separate map. Said to be the work of his two visits to the group, although it is mainly that of the second in 1823, it is rather a rough piece of surveying and in addition appears to have been carelessly laid down, for not one of his three major "fixes"[4] corresponds exactly with its plotted position in the chart. Moreover, Brisbane's boats seem to have overlogged their westerly distance so that the south coast of Coronation Island relatively to the north has been given an exaggerated length. The boats, however, appear to have found the anchorage now known as Falkland Harbour (see p. 341) and also discovered the existence of Signy Island (see p. 325 and Fig. 9) although it is left unnamed in Weddell's chart. The present Powell Island (Fig. 9), which was correctly charted by Powell as a single island, is divided by Weddell into a northern Dibdin's Island and a southern Cruchley's Island, the two being separated by a narrow strait.

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[1] Weddell, J., 1825, *loc. cit.*, pp. 20–5.

[2] *Ibid.*, p. 42.

[3] See Brown, R. N. Rudmose, 1913, *The Seals of the Weddell Sea: Notes on their Habits and Distribution*, Scientific Results of the 'Scotia' 1902–4, IV, part XIII, p. 192.

[4] Recorded in the text: they are Saddle Island, West Cape and Cape Dundas.

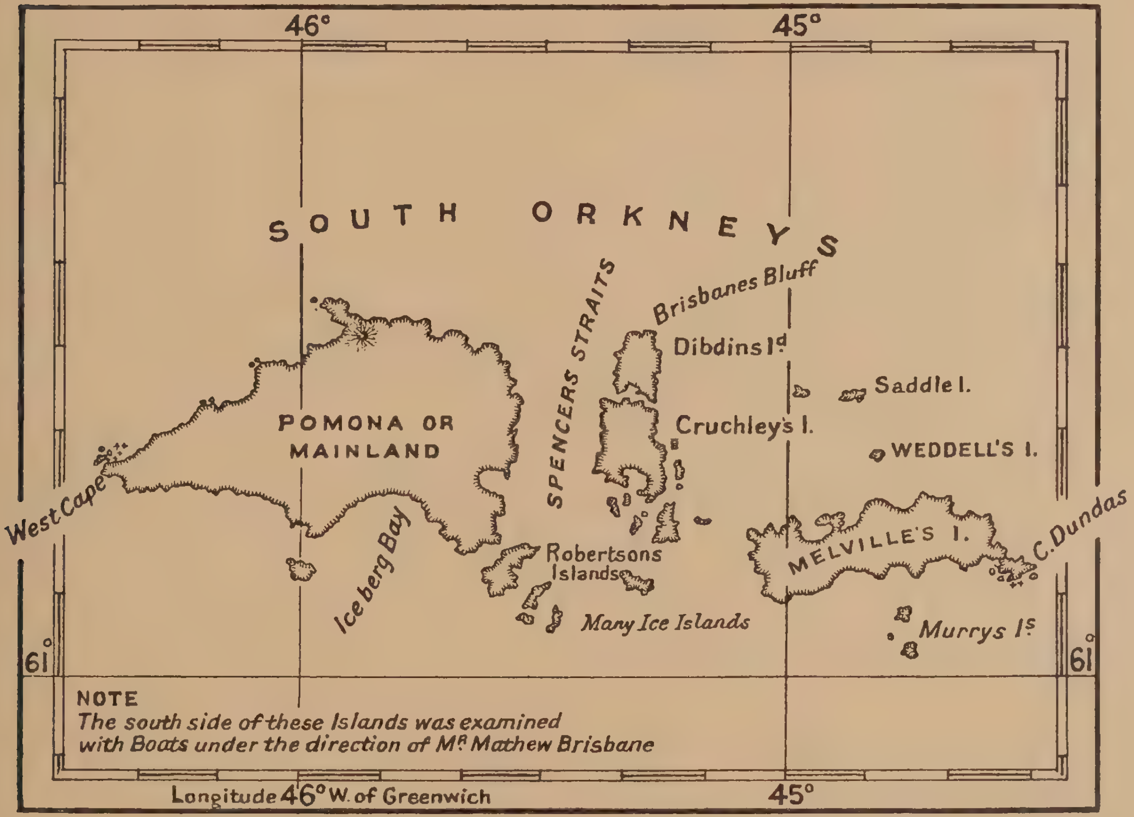
46°
45°
SOUTH ORKNEYS
SPENCERS STRAITS
Brisbanes Bluff
Dibdins Id
Saddle I.
POMONA OR MAINLAND
Cruchley's I.
WEDDELL'S I.
West Cape
Iceberg Bay
Robertsons Islands
MELVILLE'S I.
C. Dundas
Many Ice Islands
Murrys Is
61°
61°
NOTE
The south side of these Islands was examined with Boats under the direction of Mr Mathew Brisbane
Longitude 46° W. of Greenwich
45°

Fig. 4. Weddell's Chart: from the chart in *A Voyage towards the South Pole.*

Weddell, knowing nothing of Powell's previous discovery, gives entirely new names throughout his chart: for instance, Pomona or Mainland[1] for Powell's Coronation Isle, and Melville's Island[2] for Powell's Laurie's Island. That Weddell's West Cape and Powell's West Cape should be applied to almost the same point is only a natural coincidence.

Although his survey was rough Weddell definitely proved that the group terminated in the east with Cape Dundas, and a few days afterwards he finally disproved that any land existed between the South Orkneys and the South Sandwich Islands.

[1] After Pomona or Mainland in the northern Orkneys.

[2] After Viscount Melville, then First Lord of the Admiralty.

ROBERT FILDES' CHART[1]

Offering little reward for sealers the islands were not seen again until the visit of the French expedition in the 'Astrolabe' and 'Zélée' under Dumont D'Urville in 1838. In the meantime Powell's chart of 1822 was revised by Captain Robert Fildes, a sealer of Liverpool, who had made several voyages to the South Shetlands but does not appear to have visited the South Orkneys. As far as the latter are concerned his chart (Fig. 5) shows no original work, the place names and corrections to the coast-line having been taken bodily from Weddell's map and applied to Powell's unfinished chart of 1822. Although Fildes follows Weddell erroneously in splitting Powell Island into two (see p. 311), leaving both parts, however, unnamed, he notes that the positions recorded in Weddell's book do not agree with those of his chart, and accordingly opposite Cape Dundas the following legend appears: "Placed by Captn. Weddell in his description in lat. 60° 46½′ and long. 44° 35′ 45″. But, in his chart, in lat. 60° 53½′ and long. 44° 30′."

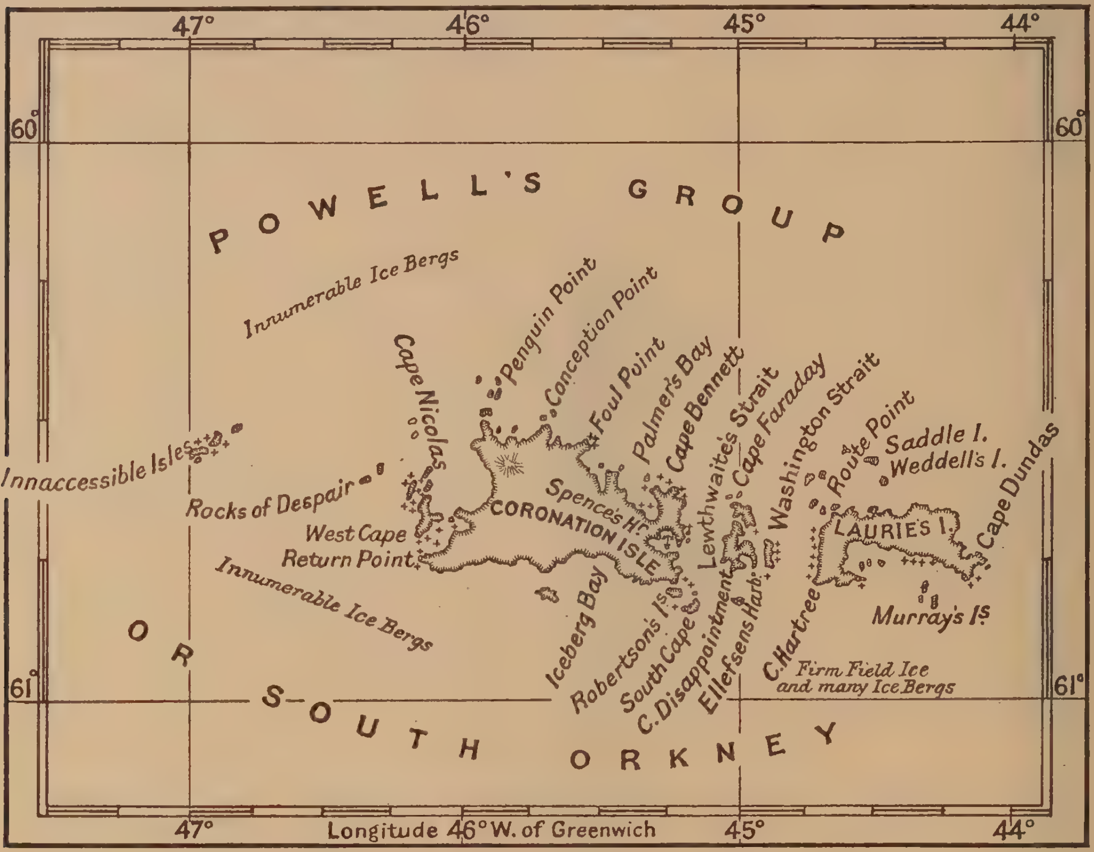
47°
46°
45°
44°
60°
60°
POWELL'S GROUP
Innumerable Ice Bergs
Penguin Point
Conception Point
Foul Point
Palmer's Bay
Cape Bennett
Lewthwaite's Strait
Cape Faraday
Washington Strait
Route Point
Saddle I.
Weddell's I.
Cape Dundas
Cape Nicolas
Innaccessible Isles
Rocks of Despair
West Cape
Return Point
CORONATION ISLE
Spences Hr.
LAURIES I.
Innumerable Ice Bergs
Iceberg Bay
Robertson's Is
South Cape
C. Disappointment
Ellefsens Harb.
C. Hartree
Murray's Is
Firm Field Ice and many Ice Bergs
61°
61°
OR SOUTH ORKNEY
47°
Longitude 46° W. of Greenwich
45°
44°

Fig. 5. Fildes' Chart: taken from *Chart of South Shetland* published by R. H. Laurie in 1831.

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[1] This chart appears in the second edition of Powell's *Chart of South Shetland, including Coronation Island, etc.*, which was published by R. H. Laurie in 1831.

DUMONT D'URVILLE[1]

Jules-Sébastien-César Dumont D'Urville sailed from France in 1837 with definite instructions from the Minister of Marine to explore that region to the south of the South Shetlands and South Sandwich Islands where Weddell had attained such a high latitude in 1823. In January and February 1838, with the corvettes 'Astrolabe' and 'Zélée', each carrying over a hundred men, D'Urville made two unsuccessful attempts to exceed Weddell's high southern record and in the course of these attempts he twice visited the South Orkneys. On the first occasion, after having been baulked in his efforts to push far south between the Elephant-Clarence group and the South Orkneys, he sighted the eastern end of Laurie Island on January 26. Rounding Cape Dundas, for the next three days he sailed west along the northern coasts of the group arriving in the meridian of the western end of Coronation Island on the 29th. The day before he had entered Lewthwaite Strait with the object of examining Spence's Harbour but had been prevented from doing so by adverse winds and tide. He now stood north-east away from the islands in very heavy weather and then again turned south and tried to push his way through the pack to the south of the South Sandwich Islands and the South Orkneys; but being again thwarted, he returned to the South Orkneys sighting Cape Dundas on February 20. He had hoped now to examine the southern side of the archipelago, but heavy ice and bad weather compelled him again to double Cape Dundas and sail along the northern coasts. On the forenoon of the 20th a party landed on Weddell Island and made a considerable collection of birds and rocks. Thereafter D'Urville continued to sail along the north coast of Coronation Island until the 22nd when he finally departed for the South Shetlands.

D'Urville gives a long and sometimes highly coloured description of his two visits to the South Orkneys, which, off and on, appear to have been accompanied by a good deal of discomfort. His crews were tired and disappointed after their recent set-back in the pack-ice and were much in need of fresh meat. Moreover, tired as they were, when the weather became bad they were compelled to ride out gales far from shelter, as D'Urville, himself in bad health, appears to have been unwilling to venture his ships close inshore on such an inhospitable coast. It is scarcely surprising that it was with some disfavour that he regarded these ice-bound islands which he describes in the somewhat too vivid and long-drawn-out manner that was fashionable at the time. "Nul aspect au monde", he writes, "ne peut être plus triste, plus repoussant que celui de ces contrées désolées. Après s'être longtemps promené sur les plaines immenses de glaces qui s'étendent sans interruption de la base jusqu'au sommet de cette chaîne de montagnes, l'œil fatigué s'attriste encore plus en s'arrêtant sur ces rochers nus, arides et escarpés dont la teinte noire et lugubre vient seule rompre la blanche uniformité de la côte." Besides D'Urville's own account there are copious notes by his officers, all of whom are agreed regarding the desolate and fearful nature of the country, and the enormous numbers of icebergs of diverse and sometimes grotesque shape that were encountered in its vicinity and greatly enhanced the difficulty of navigation with crews already fatigued. Vincendon Dumoulin, D'Urville's hydrographer, refers to the South Orkneys in particularly forceful language: "Terre de deuil et de frimats, partout même aspect, de longues et stériles montagnes couvertes de neige. Voilà les îles Powell."

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[1] See *Voyage au Pôle Sud, Histoire du Voyage*, 1, p. viii, 2, pp. 41–138, 230–41 and 314–20.

The French, however, saw only the northern coasts of the group, which in certain parts of Coronation Island at least, are low, gently sloping and covered with an almost continuous ice-sheet (a fact which was noted by D'Urville when he was off its north-western corner), while its southern coast in contrast is generally more rugged and steep and in consequence characterized by much more ice-free rock.

Among his observations on the natural history of the group D'Urville records very large numbers of whales, of which some were Humpbacks and others Right whales. No seals are mentioned, but this is not surprising as he was generally so far off the land that he must have been unable in any case to note their presence or absence. His record of Right whales, however, the earliest notice of the presence of this species at the South Orkneys, is of peculiar interest; for recently evidence has been found which suggests that the old Right whalers themselves may have visited the group about this time, 1837–46, when the industry was at its height and great fleets of Sperm and Right whalers roamed the Southern Ocean.[1] It appears that the expedition on its return to France learnt that certain whalers had brought rocks, said to be of volcanic origin, from the South Orkneys to the Natural History Museum of Edinburgh.[2] The French, who had collected rocks which were certainly not volcanic from Weddell Island, were unable to obtain any further information regarding the Edinburgh specimens; and as recent enquiries at the Royal Scottish Museum have been equally unproductive,[3] the possibility that the South Orkneys were visited by whalers at this early date must remain an interesting speculation.

THE FRENCH CHART

D'Urville's chart of the South Orkneys (Fig. 6), which is the work of his hydrographer, Vincendon Dumoulin, was published in 1847 in D'Urville's Atlas. In spite of the fact that D'Urville complains of the inaccuracy of the 1831 edition of Powell's chart by Fildes (Fig. 5), of which he had a copy on board, and although one of his major reasons for visiting the group was in order to make a good survey of it, the French chart, chiefly because the southern coasts were left untouched, adds less than might be expected to the existing chart of 1831. Besides his work on the northern coast-line of Laurie Island and of Coronation Island, Dumoulin has roughly fixed the heights of various prominent peaks and headlands throughout the group. He rightly attempts to re-unite the Cruchley's and Dibdin's Islands of Weddell by a narrow isthmus, leaving both parts however unnamed, but he makes a curious error in regarding what is now Jessie Bay at the north-western end of Laurie Island, as being confluent with the present Scotia Bay to the south, so that Laurie Island appears to be divided in two by a narrow channel at its western end. The French add only two new names to those of Powell and Weddell already existing: Pte Chaumont and C. Valavielle, both given to prominent points on the north coast of Laurie Island. Pte Chaumont, however, wrongly displaces Powell's original Route Point.

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[1] Harmer, S. F., 1928, *The History of Whaling*, Proc. Linn. Soc. Lond., pp. 63–5.

[2] *Voyage au Pôle Sud*, Géologie, etc., 1848, p. 32 (Paris).

[3] Dr A. C. Stephen, Keeper of the Natural History Department of the Royal Scottish Museum, Edinburgh, has kindly searched the registers which cover this period and has also made enquiries at the Geological Department of Edinburgh University, but has failed to trace these specimens or to find any reference to them.

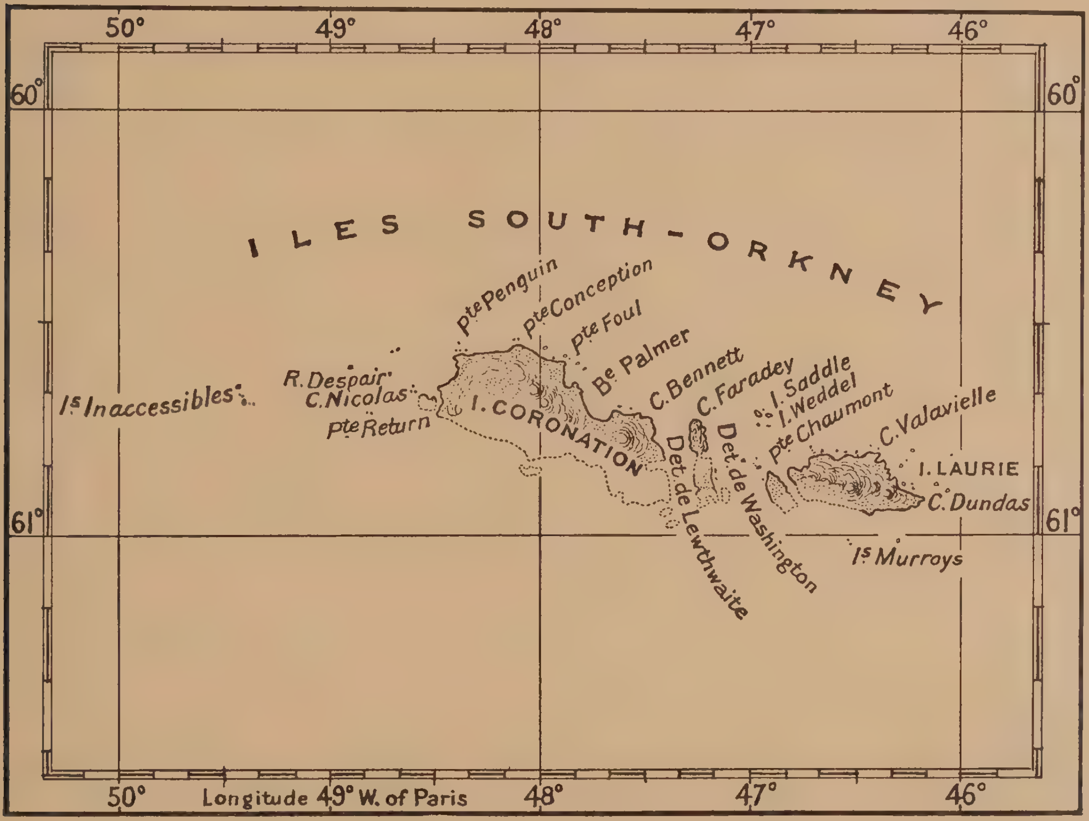
50°
49°
48°
47°
46°
60°
60°
61°
61°
ILES SOUTH-ORKNEY
Pte Penguin
Pte Conception
Pte Foul
Be Palmer
C. Bennett
C. Faradey
I. Saddle
I. Weddel
Pte Chaumont
C. Valavielle
Is Inaccessibles
R. Despair
C. Nicolas
Pte Return
I. CORONATION
Det de Lewthwaite
Det de Washington
I. LAURIE
C. Dundas
Is Murroys
50°
Longitude 49° W. of Paris
48°
47°
46°

Fig. 6. The French Chart: taken from D'Urville's Atlas, Plate 43, Paris, 1847.

THE BRITISH ADMIRALTY CHART, NO. 1238

Although D'Urville's Atlas (in which Fig. 6 appears) was not published until 1847, a much earlier chart of the South Orkneys also based on Vincendon Dumoulin's work was published in 1838 in *Annales Maritimes et Coloniales*. The original of this chart accompanied one of D'Urville's first despatches to France on the early work of the expedition dated "25th May 1838, at sea".[1] This chart must be regarded as being of a preliminary nature, a "croquis provisoire", and as such it differs in certain important details from the final form of Dumoulin's work (Fig. 6). For instance there is no attempt to join Dibdin's and Cruchley's Islands, Laurie Island is not divided in two at its western end, and the two important French names, Pte Chaumont and C. Valavielle, are not inserted. Nevertheless it is of considerable interest, as the British Admiralty Chart No. 1238, Hydrographic Office, September 7, 1839, at least as far as the South Orkneys are concerned, appears to have been taken directly from it. A copy of this chart, corrected to 1844, is shown in Fig. 7. In it for the first time Dibdin's and Cruchley's Islands appear under the name of Powell Islands, but otherwise it follows Dumoulin's preliminary chart in every detail. As no charting of any kind was done at the South Orkneys for the remainder of the nineteenth century, these islands have not been altered in shape in any subsequent issue of No. 1238 until Bruce's map of Laurie Island (Fig. 8) was incorporated in it as a small correction in 1905. Moreover, as No. 1238 was finally withdrawn from circulation in 1925 as a result of surveys by Norwegian whalers, the Coronation Island at least of the British Admiralty Charts has retained the shape assigned to it by the French expedition in 1838 for more than eighty years.

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[1] I am indebted for this information to Monsieur G. Grandidier, Secretary of the French Geographical Society.

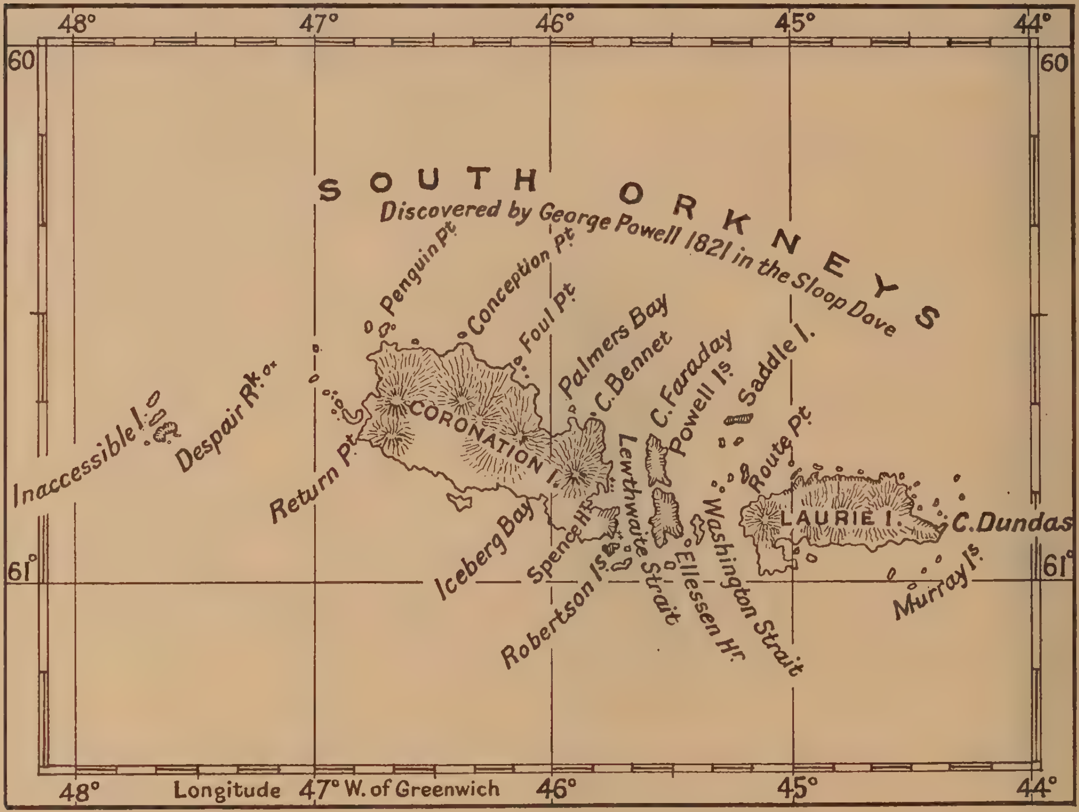
48°
47°
46°
45°
44°
60
60
SOUTH ORKNEYS
Discovered by George Powell 1821 in the Sloop Dove
Penguin Pt.
Conception Pt.
Foul Pt.
Palmers Bay
C. Bennet
C. Faraday
Powell Is.
Saddle I.
Inaccessible I.
Despair Rk.
Return Pt.
CORONATION I.
Iceberg Bay
Spence Hr.
Robertson Is.
Lewthwaite Strait
Ellessen Hr.
Washington Strait
Route Pt.
LAURIE I.
C. Dundas
Murray Is.
61°
61°
48°
Longitude 47° W. of Greenwich
46°
45°
44°

Fig. 7. The British Chart: taken from Chart No. 1238 published by the Admiralty on September 7, 1839.

DALLMANN, LYNCH AND LARSEN

Following the visit of the French expedition in 1838 the South Orkneys remained in comparative obscurity until the beginning of the twentieth century. During a period of sixty-five years only three navigators, none of whom contributed anything to the hydrography of these islands, are definitely known to have visited them: the German sealer and explorer Eduard Dallmann, the American sealer Thomas B. Lynch, and the Norwegian whaler C. A. Larsen. Except for the visit of Dallmann it is rather surprising that the important secondary revival of sealing which took place at the South Shetlands between 1872 and 1888[1] does not appear to have involved the South Orkneys, not at least so far as can be definitely ascertained at present; but although Dallmann is the only sealer who is known to have taken seals in any quantity off the South Orkneys throughout their history, it is probable that others who have left no record of their wanderings may also have gone there, if not during the sixteen years of the South Shetlands' revival at any rate towards the end of last century. Of these more will be said later (p. 319).

In the latter part of the season 1873–4 Captain Eduard Dallmann[2] in the steam whaler 'Grönland', following his work at the South Shetlands and on the west coast of Graham Land, spent several days sealing at the South Orkneys. Approaching from the south-west he sighted Coronation Island on the morning of January 28, 1874, and that afternoon, being up with the land, despatched his boats in search of seal. They landed on the south-western corner of Coronation Island,[3] and for the first time in the history of the group encountered fur, elephant and Weddell seals in considerable quantity,[4] a rather surprising revelation when we recall how very few seals of any species were recorded by Powell and Weddell more than fifty years earlier. In this locality the 'Grönland' remained for two-and-a-half days. The boats were constantly at work, and on Dallmann's own admission his men appear to have killed every seal—fur, elephant, and Weddell—that they could lay hands on: "after this" he writes "this place was perfectly exhausted". On the morning of the 31st another landing was made on the south coast slightly more to the east and then Dallmann proceeded towards Lewthwaite Strait standing off and on the land, of which he had occasional glimpses, in very bad weather and among many icebergs. The 'Grönland' by now appears to have been leaking badly, for scarcely a day passes without the entry in her log "pumping long"; moreover scurvy had broken out, for in a later entry Dallmann records how the disease was declining owing to the consumption of raw penguin meat. At noon on February 4 he entered Lewthwaite Strait and tried to reach Spence's Harbour, but thick weather accompanied by a stiff northerly breeze compelled him to put about and run south under full sail through the icebergs which filled the strait. At length he found shelter in a small bay on the east coast of Coronation Island somewhat south of Spence's Harbour; and here the 'Grönland' lay comfortably at anchor for two days while her boats examined both sides of the strait for seals with moderate success.

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[1] Matthews, L. H., 1931, *South Georgia: The British Empire's Subantarctic Outpost*, p. 82 (Bristol and London).

[2] This account is based on the original log of the 'Grönland' now in the library of the Geographical Institute of Gotha.

[3] The exact locality is not stated but it may have been slightly to the eastward of Return Point.

[4] Full details are given in the section on seals, pp. 371–6.

On the afternoon of the 6th Dallmann stood out of Lewthwaite Strait and proceeded westward along the south coast of Coronation Island meeting with exceptionally severe weather in which he lost two of his boats with all their gear. He reached the western end of the island on the 9th and on the following day landed on "Return Island"[1] where some fur and Weddell seals were found, all apparently being killed. He finally left the South Orkneys on February 11.

The next visitor to the South Orkneys was the American sealer, Captain Thomas B. Lynch, in the schooner 'Express'. According to Balch[2] Lynch went to the South Orkneys some time in 1880 in order to search for a missing ship called the 'Charles Shearer', which, under Captain James Appleman, of Mystic, Connecticut, had sailed from Stonington for the South Shetlands the year before but had not been heard of again.

In the spring of 1892 the Norwegian whaler C. A. Larsen[3] called at the South Orkneys while outward bound in the 'Jason' on his first southern voyage, arriving off the north coast of Laurie Island on November 16. The following day he landed on a part of the coast, which, although he does not state the exact locality, appears to have been either Brown or Macdougal Bay (Fig. 8). As they approached the shore his boats ran great risk of being swamped by calving icebergs which lay thickly across their path, forming long narrow passages through which they had to pass, and in consequence Larsen called for volunteers rather than order his men into a situation so full of danger.

From Laurie Island the 'Jason' sailed westwards, arriving at Palmer's Bay which was found to be clear of ice on the 21st, and at Foul Point in the last week of November. From there she evidently rounded the north-western corner of Coronation Island and proceeded on her way to Trinity Land which she sighted on December 2.

At his landing-place on Laurie Island Larsen observed vast numbers of penguins (evidently ringed penguins) and one peculiar individual which he called the "Queen Penguin"—possibly a macaroni or a gentoo. Of seals he records crab-eater, Weddell and leopard, but no fur or elephant.

Humpback whales were seen in great numbers and some Bottlenoses, but not a single Right whale; nor are Blue or Fin whales mentioned, but Larsen's "hvaler" would no doubt include these.

UNRECORDED VOYAGES

C. A. Larsen is the last of these few nineteenth-century voyagers to the South Orkneys of whom there is definite knowledge. It has already been suggested, however, that the group may have been visited by certain sealers who have left no record of their movements. Although Dallmann almost certainly exterminated the fur seals in the vicinity of the south-western corner of Coronation Island in 1874, this is not sufficient reason for supposing that he had then taken the last of the species from the group. Some at least of the many localities he did not visit may still have been harbouring fur seals after 1874; and the fact that none has been recorded in recent years suggests that the South Orkneys, on more occasions than one, must have been the haunt of sealers, probably towards the end of last century. The last remnants of this once-flourishing stock appear to have been taken from the South Sandwich Islands by Canadian sealers about 1907,[1] and Dr R. N. Rudmose Brown, who met and spoke with some of these sealers at Port Stanley in 1903, would seem to imply[2] that they were involved in the final extermination of the species at the South Orkneys as well: "since then"[3] he writes "apparently, no sealer has thought these islands worthy of his attention, unless it be perhaps some of the little Canadian sealers who still, to the number of over a dozen, frequent these southern seas, making the Falkland Islands their headquarters. Some of them have as likely as not been to the South Orkneys: I have it from their own lips that they know the South Sandwich Group and the South Shetlands, but a canny northern discretion forbids them to say much of what they found there".

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[1] There is no Return Island: Dallmann must mean the Larsen Islands west of Sandefjord Bay (see Fig. 9).

[2] Balch, E. S., 1904, *Antarctica Addenda*, Journ. Franklin Inst., CLVII, pp. 83–4 (Philadelphia).

[3] I am indebted for details of Larsen's visit to the South Orkneys to Mr Bjarne Aagaard, who sent me all the information that could be verified in Norway regarding this visit.

Elsewhere[4] the same author states that the sealers who used to winter their small schooners at Port Stanley were Nova Scotian and British Columbian. "They are naturally" he says "unwilling to divulge the exact whereabouts of their sealing-grounds; but doubtless many sub-Antarctic islands are well known to them—better known, perhaps, than scientific geographers would believe."

RECENT RESEARCH AND COMMERCIAL EXPLOITATION

THE SCOTTISH NATIONAL ANTARCTIC EXPEDITION[5]

At the beginning of the twentieth century the South Orkneys were still virtually an unknown scientific field, but it was at last opened up as a result of the work of the Scottish National Antarctic Expedition under the leadership of W. S. Bruce in the S.Y. 'Scotia'. In the course of her first southerly voyage into the Weddell Sea the 'Scotia' sighted the South Orkneys on February 3, 1903, and on the following day a party landed on Saddle Island, where it made the first important geological and biological collection since D'Urville's landing on Weddell Island in 1838. The 'Scotia' returned to the South Orkneys from the south on March 21 seeking a safe harbour in which to pass the winter, but found the only harbours then known in the group, Spence's and Ellefsen's, to be quite unsuitable. Eventually on March 25 a safe anchorage was found at the head of Scotia Bay (Fig. 8) at the south-western end of Laurie Island. Two days later pack-ice filled the bay and the 'Scotia' remained there firmly beset until November 23 when the ice began to break up. On November 27 she left the South Orkneys for Buenos Aires in order to refit, returning again on February 14, 1904. On February 22 she finally left the South Orkneys, and cruising into the Weddell Sea eventually penetrated to 74° S and discovered Coats Land.

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[1] Brown, R. N. Rudmose, 1927, *The Polar Regions*, p. 140 (London).

[2] See *The Voyage of the 'Scotia'*, p. 73.

[3] Since Weddell's second visit to the South Orkneys in 1823.

[4] *The Voyage of the 'Scotia'*, p. 199.

[5] Except where otherwise indicated, the bulk of this account, and part of that of the Argentine Meteorological Station which follows, is taken from *The Voyage of the 'Scotia'* by R. N. Rudmose Brown, R. C. Mossman, and J. H. Harvey Pirie, 1906 (Edinburgh and London), which contains an excellent account of the life and general work of the expedition on Laurie Island. Full details of the scientific work of this important expedition may be found in the *Report on the Scientific Results of the Voyage of S.Y. 'Scotia'*, I–VI, 1907–20 (Edinburgh), and in the Transactions of the Royal Society of Edinburgh.

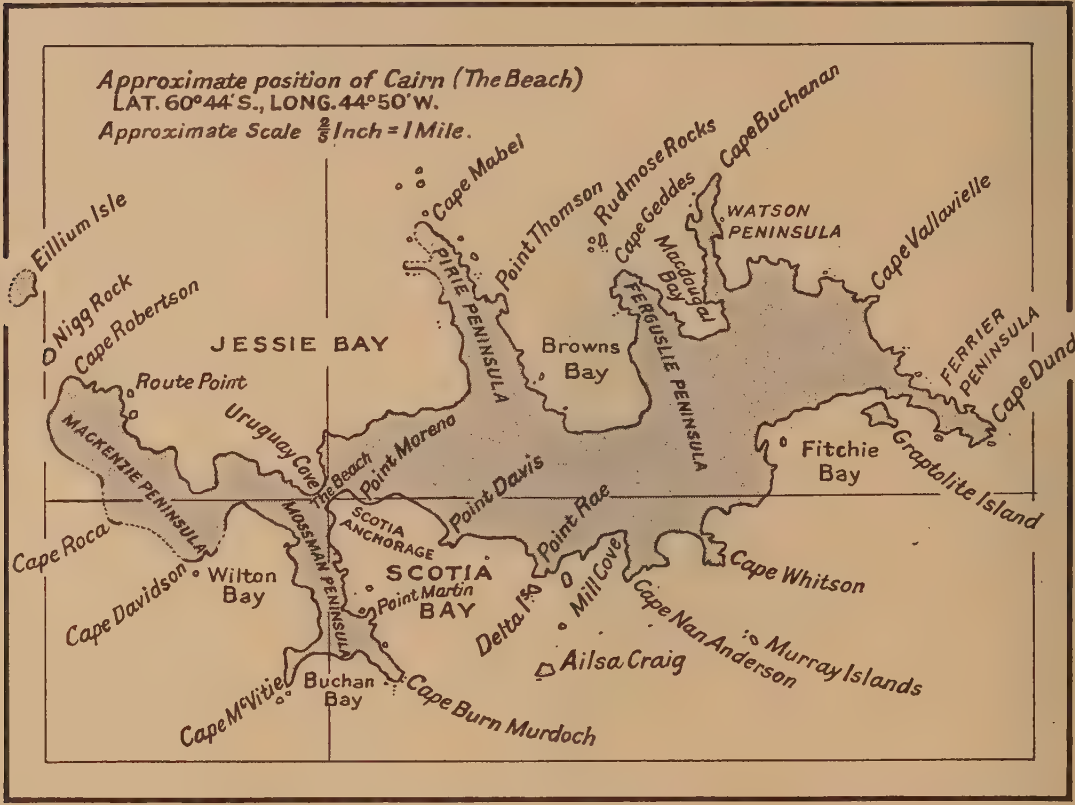
Approximate position of Cairn (The Beach)
LAT. 60°44' S., LONG. 44°50' W.
Approximate Scale ⅝ Inch = 1 Mile.
Eillium Isle
Nigg Rock
Cape Robertson
JESSIE BAY
Route Point
Uruguay Cove
The Beach
Point Moreno
MACKENZIE PENINSULA
Cape Roca
Cape Davidson
Wilton Bay
MOSSMAN PENINSULA
SCOTIA ANCHORAGE
SCOTIA BAY
Point Martin
Cape McVitie
Buchan Bay
Cape Burn Murdoch
Point Davis
Point Rae
Delta Isᵈ
Mill Cove
Ailsa Craig
Cape Mabel
PIRIE PENINSULA
Point Thomson
Rudmose Rocks
Cape Geddes
Cape Buchanan
Macdougal Bay
WATSON PENINSULA
Browns Bay
FERGUSLIE PENINSULA
Cape Vallavielle
FERRIER PENINSULA
Cape Dundas
Fitchie Bay
Graptolite Island
Cape Whitson
Cape Nan Anderson
Murray Islands

Fig. 8. Bruce's Chart of Laurie Island: from the outline map in *The Voyage of the 'Scotia'*.

As far as the South Orkneys are concerned the 'Scotia's' observations were entirely confined to Laurie Island and certain of its off-lying islets, apart from the single landing on Saddle Island already mentioned and a brief landing of about ten minutes' duration on the east coast of Coronation Island in March 1903 during the search for a winter harbour.

In addition to its pioneer oceanographical work in the Weddell Sea and its comprehensive observations on the fauna and flora, and on the geology and glaciology of Laurie Island, two notable achievements of this expedition are worthy of special mention. The first was the establishment by Bruce of a meteorological and magnetic station at Laurie Island on the narrow strip of low ground, known as the Beach, which separates Scotia

Bay from Uruguay Cove. This station is still being carried on at the present day, although now under Argentine control (see below). The second was a complete triangulated survey of Laurie Island by Bruce, assisted by Brown, Pirie and Wilton, which was made during the winter and spring of 1903 by sledge and boat parties. The conditions under which this work was carried out were severe, especially in winter; the precipitous nature of the coast-line, cut by many glaciers, made land sledging for the most part impracticable and the surveyors were compelled to sledge over rough sea-ice, which in the winter of 1903 was not compact and immovable but constantly shifting, so that the sledging parties were often in danger of being swept out to sea on floating ice. The unsatisfactory condition of the sea-ice for travelling was the main reason why the expedition was unable to attempt a similar survey of Coronation Island. The result of this careful and accurate triangulation revealed Laurie Island as having an almost fantastic shape (Fig. 8) of which there is scarcely any indication in the hurried surveys of last century, and considering the difficulties under which it was carried out the Scottish expedition is to be congratulated on this sound contribution to the hydrography of the islands. The whole of the extraordinarily indented coast-line of Laurie Island was surveyed in great detail with the exception of about three miles of the west coast of Mackenzie Peninsula and the west side of Eillium Isle. The west coast of Pirie Peninsula also was not surveyed in such detail as the rest.[1] In addition to the plotting of the coast-line many heights in the rugged interior were fixed and over five hundred inshore soundings were made—arduous work in winter, for each sounding involved cutting through ice often thirty inches thick.

THE ARGENTINE METEOROLOGICAL STATION[2]

Hourly meteorological observations were first begun at Laurie Island on board the 'Scotia' as she lay fast in the ice in Scotia Bay during the winter of 1903. On November 1 they were transferred to the shore station, Omond House, a substantial one-roomed stone dwelling built on the "drydike" principle, which had been erected on the Beach. A small magnetic hut was also built there. While the 'Scotia' was being refitted in Buenos Aires a small party under Mr R. C. Mossman remained to carry on the observations at the South Orkneys. In 1904 the British Minister at Buenos Aires communicated to the Argentine Government an offer from Bruce to convey to the South Orkneys four Argentine scientists in whose care he would place the observatory. This offer was accepted. The first Argentine staff was carried by the 'Scotia' on her return to the South Orkneys in February 1904, Mr Mossman remaining in charge of the work for the first year of Argentine control. Since then various changes have taken place in the original equipment of the station: a new magnetic hut was built in 1905 and a wooden building erected in 1906 in place of the old Omond House which is now partially demolished. In 1927 a wireless station was built which transmits weather observations to Buenos Aires daily (Plate XII, fig. 2).

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[1] See Bruce, W. S., 1905, *Outline Map of Laurie Island*, Scott. Geog. Mag., XXI, p. 322.

[2] Fuller accounts of this station, to which the author is indebted, will be found in the *Annals of the Argentine Meteorological Office*, XVI, pp. 7–24, 1905 (Buenos Aires), and XVII, part 1, pp. 3–7, 1912 (Buenos Aires). See also Passera, Gino de, 1932, *Eroi Argentini alle soglie del Polo Sud*, Le Vie d' Italia e dell' America Latina, XXXVIII, pp. 351–60.

While routine meteorological and magnetic observations absorb most of the time of the staff, from time to time interesting biological observations have been made and some local mapping and sounding has been done in the neighbourhood of the station.

The staff are relieved annually about the middle or towards the end of summer. For a long time the Argentine gunboat 'Uruguay' used to make the voyage from Buenos Aires each year, except in the season 1905–6, when Charcot's vessel 'Le Français' was employed.[1] In more recent years the annual relief has frequently been carried out by means of a whale-catcher from South Georgia.

THE ARGENTINE CHART

A chart of the South Orkneys was published in Buenos Aires in 1930. It consists of a general chart of the group with two large-scale insets, one of the western end of Laurie Island including Powell and Saddle Islands, the other of the anchorages in Scotia Bay and Uruguay Cove. It is said to be based on surveys by two Argentine naval officers, I. Espindola (1915) in the 'Uruguay', and A. Rodriguez (1930) in the '1° de Mayo'. The work on the western end of Laurie Island and in the two anchorages seems to have been carefully executed but the general chart of the group, as a piece of original work, has little to commend it. It appears to have been taken largely, and not always faithfully, from Sörlle's chart of 1912–13 and together with the large-scale maps, it is sprinkled freely with misplaced and misspelt Scottish and Norwegian names. Bruce's Wilton Bay for example is called Bª Whitson while Sörlle's Michelsen Island becomes Milkensen Island. There are many other inaccuracies of a similar nature.

THE WHALERS[2]

In recent years the South Orkneys have been visited by a number of whaling expeditions. The Antarctic whaling industry did not spread to the South Orkneys until the summer season 1911–12, although an unsuccessful attempt had been made to use the islands as a whaling base in the season 1907–8. As at the South Shetlands the industry was carried on only during the summer months by means of floating factory ships anchored in harbours, roadsteads and sheltered places in various parts of the group, each factory generally being accompanied by two whale-catchers. Although a small land station was built at Borge Bay in Signy Island in 1920–1, it was used only in conjunction with a floating factory which was responsible for the major part of the oil production (see below, p. 324).

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[1] On the return of the first French Antarctic Expedition to Buenos Aires in May 1905 that vessel was bought by the Argentine Ministry of Agriculture and re-named 'El Austral'. Under Captain Lorenzo Saborido she sailed from Buenos Aires on December 29, 1905, carrying, in addition to the relieving staff and stores for their sustenance, materials for the new house. Having called at Ushuaia she reached the vicinity of the South Orkneys on January 30, 1906, a landing being effected on February 2. The 'Austral' remained three weeks at the South Orkneys while the sections of the new house were assembled and erected. She sailed for South America on February 23. The 'Austral', which might have made many voyages to the South Orkneys, was wrecked on the Banco Chico in the River Plate in December 1907.

[2] See *Report of the Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands*, pp. 3, 6, 42–3, 49, 57–8. The author is further indebted for details of the whaling industry to Mr Sigurd Risting, Sandefjord, and to reports in the Colonial Office from whaling officers at the South Orkneys.

There have been two periods of whaling activity at the South Orkneys; the first, which started in the season 1911–12, came to an end with that of 1914–15, when owing to the war the number of floating factories employed in the far southern Dependencies of the Falkland Islands began to fall away considerably owing to losses sustained through enemy action and the diversion of vessels to the business of carrying burning oil from the United States to France and Great Britain.[1] The second dates from 1920–1 until 1929–30, when with the rapid and highly successful expansion of pelagic whaling this old method of operating from factory ships sheltered in territorial waters was finally abandoned.

Although whales were generally plentiful enough, the shortness of the season, combined with bad weather and difficult ice conditions, so hampered whaling operations on this new field during the first period of its exploitation that it was by far the least profitable of the grounds in Dependencies of the Falkland Islands. Free access to the islands was generally prevented by the presence of pack-ice to the northward, even in early summer, and the factory ships were unable to reach the shelter of the land until the beginning and sometimes the middle of January. In the season 1914–15, when heavy pack extended for a hundred miles north of the group, the 'Falkland' did not reach her anchorage until as late as January 19. Thus, as it was considered advisable to leave this field about the middle of March owing to the approach of bad weather and the possibility of the islands again becoming congested with ice, the time left for actual whaling was exceedingly short. The work of the whale-catchers, strenuous as it is even under the best conditions, must often have been seriously handicapped by fog and gales in a region where stranded and floating icebergs are unusually numerous (Plate XIII).

Table I

Season	Company	Floating factory
1911–12	Rethval Whaling Company of Oslo	'Falkland'
1912–13	Rethval Whaling Company of Oslo	'Falkland'
	Thule Whaling Company of Oslo	'Thule'
	Normanna Whaling Company of Sandefjord	'Normanna'
	Corral Whaling Company of Bergen	'Tioga'
1913–14	Rethval Whaling Company of Oslo	'Polynesia'
	Thule Whaling Company of Oslo	'Thule'
	Normanna Whaling Company of Sandefjord	'Normanna'
1914–15	Rethval Whaling Company of Oslo	'Falkland'

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[1] *Report of the Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands*, pp. 6, 43.

An early attempt, perhaps the earliest, at true pelagic whaling in the Antarctic appears to have been made at the beginning of the season 1912–13, when the factories began fishing on the ice-edge before the pack had cleared away from the land and obtained about two thousand barrels of oil before reaching harbour.

Table I shows the Norwegian Companies actually working, together with the floating factories which they employed, during the first four seasons of whaling at the South Orkneys.

The 'Falkland' and 'Normanna' were torpedoed and lost during the war.

One company only, the Tönsberg Hvalfangeri of Tönsberg, held a permanent base at the South Orkneys during the ten seasons of the period 1920–30.[1] A transport or floating factory was sent annually to Borge Bay on the north-eastern side of Signy Island, where whaling was carried on for some time in conjunction with a small land station but latterly by floating factory alone. This company achieved greater success than any of its predecessors, partly owing to its more up-to-date equipment and partly because the seasonal catch of whales was generally augmented to a greater or less extent by pelagic fishing at the ice-edge while waiting for the islands to become clear. The land station built in the season 1920–1 was only of secondary importance. By dealing with carcases already stripped of their blubber by the attending transport or floating factory it was able to augment the quantity of oil produced on board. It was never very efficient, and had apparently ceased to operate in the season 1925–6 when a floating factory arrived with an equipment more complete than that of her predecessors and the land station became no longer necessary. During these ten years the Tönsberg company sent three different vessels to Borge Bay: first the transport 'Teie' followed by the converted transport 'Orwell' (now 'Congo'), and latterly the present larger and more up-to-date 'Orwell', which replaced her earlier namesake in the season 1925–6 and continued to fish annually at the South Orkneys until the season 1929–30 when territorial whaling was abandoned there.

The species of whales commonly found in other parts of the Dependencies were taken at the South Orkneys, viz., Blue and Fin whales and Humpbacks, with a very occasional Sperm, Right, or Bottlenose. As a rule Fin whales predominated, especially in the very open or ice-free years, while Blue whales were generally in the majority when the islands were much congested with pack. The Humpback formed quite an important constituent of the catch during the first three seasons (1911–14) of the pre-war period, but thereafter very few were taken.[2]

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[1] Other floating factories, however, both British and Norwegian, notably the 'Lancing', 'Southern Queen', 'Sevilla', 'Saragossa' and 'Solstreif', began to fish in a pelagic or semi-pelagic way in the neighbourhood of the islands during and immediately after the season 1925–6 when pelagic whaling was in the initial stages of its development.

[2] For whaling statistics see *Report of the Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands*, Appendix v, p. 61; and also Harmer, S. F., 1928, *The History of Whaling*, Proc. Linn. Soc. Lond., p. 93.

NORWEGIAN HYDROGRAPHIC WORK[1]

The first need of the whalers in their new field was to find harbours where the floating factories might lie in safety and obtain sufficient fresh water for their boilers. At the same time they wanted a reliable working chart of the entire group, of which only Laurie Island with its off-lying rocks and islets was known with any accuracy. Coronation Island still appeared on the British Admiralty Charts on a scale too small to be of any use to seamen—exactly as the French had left it in 1838 (see p. 316, Fig. 7)—and nothing was known of what dangers to navigation existed around its coast.

At the end of 1911 the late Captain Petter Sörlle,[2] with the whale-catcher 'Powell', was sent on ahead of the 'Falkland' in order to find her a suitable anchoring place. This expedition appears to have contemplated using the South Sandwich Islands as an alternative base, for Captain Sörlle investigated that group before leaving for the South Orkneys, where at the southern end of Powell Island he appears to have found the anchorage later known as Falkland Harbour. Here the 'Falkland' lay for about one and a half months during her first season.

The following season, 1912–13, Captain Sörlle, while employed as gunner of the 'Palmer', a whale-catcher belonging to the 'Thule' and under the management of Captain H. G. Melsom, made running surveys of Coronation, Signy, Powell and Fredriksen Islands, plotting in great detail the rocks and islets with which the coasts of all are beset. The resulting chart of the whole group (Fig. 9) was by far the best of any published up to that time, and although apparently indebted to Bruce for Laurie Island, it reflects great credit on the diligence and patience of its author, a whaler working under the arduous and uncomfortable conditions that are characteristic of his occupation. In addition to a number of soundings Captain Sörlle made detailed sketch-plans of certain important harbours and anchorages, notably Ellefsen's Harbour and Falkland Harbour at the southern end of Powell Island, as well as Queens Bay, Paal Harbour, and Palmer Bay[3] in Signy Island. Signy Island, it may be recalled, is the small island adjoining the middle part of the southern coast of Coronation Island, the existence of which was apparently first made known by Matthew Brisbane in his small boats. It appears for the first time, unnamed and very roughly plotted, in Weddell's chart of 1825 (Fig. 4), and is now named after Captain Sörlle's wife, Mrs Signy Sörlle. It is perhaps of interest to note here that the Powell Islands of the British Admiralty Chart of 1839 (p. 316, Fig. 7) at last appear in their true form as a single island (Powell Island), as originally charted by Powell himself in 1821.

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[1] For details of this section the author is much indebted to Mr Sigurd Risting, Sandefjord, and to a letter from Captain J. R. Stenhouse, Master of the R.R.S. 'Discovery', to the Secretary of the Discovery Committee. Official reports in the Colonial Office from whaling officers at the South Orkneys have also been consulted.

[2] In January 1912, Captain Sörlle, who was gunner of the 'Powell', shot the first whale at the South Orkneys—a Humpback.

[3] There is another and much larger "Palmer's Bay" on the north coast of Coronation Island, which appears in Powell's earliest chart of the group, a fact which Sörlle seems to have overlooked.

In the season 1913–14 an important addition was made to Sörlle's work by Captain Hans Borge, master of the 'Polynesia', who mapped the small harbour at the head of Queens Bay in Signy Island which now bears his name.

The many new names which appear on Sörlle's chart are in the main derived from the Norwegian whaling community, being in general called after the managers and gunners, floating factories and whale-catchers, employed at the time.

Of all the anchorages frequented by the whalers Queens or Borge Bay, being comparatively safe and well supplied with fresh water, appears to have been the most favoured. It was used by all three factories, 'Polynesia', 'Thule' and 'Normanna', during the season 1913–14 and by the 'Falkland' the following year; later it served as a base for ten successive seasons after whaling was resumed at the South Orkneys in the season 1920–1. Here the 'Orwell' used to lie permanently moored for the season with heavy ground tackle forward and heavy cables and wire to the rocks astern of her. Even in Borge Bay which is perhaps as good as any in the group where none is perfect, the whalers were often subjected to considerable inconvenience. Pack-ice would occasionally drive in and block the entrance so that for many days the catchers could neither enter nor depart and work was completely at a standstill. At other times heavy swells would come in causing the factory to pitch so violently that flensing became impossible and whales waiting to be flensed were torn from their strong moorings and cast up on the beach, from which, however, it was generally possible to retrieve them. Falkland Harbour, first used by the 'Falkland' in the summer of 1911–12, although regarded as

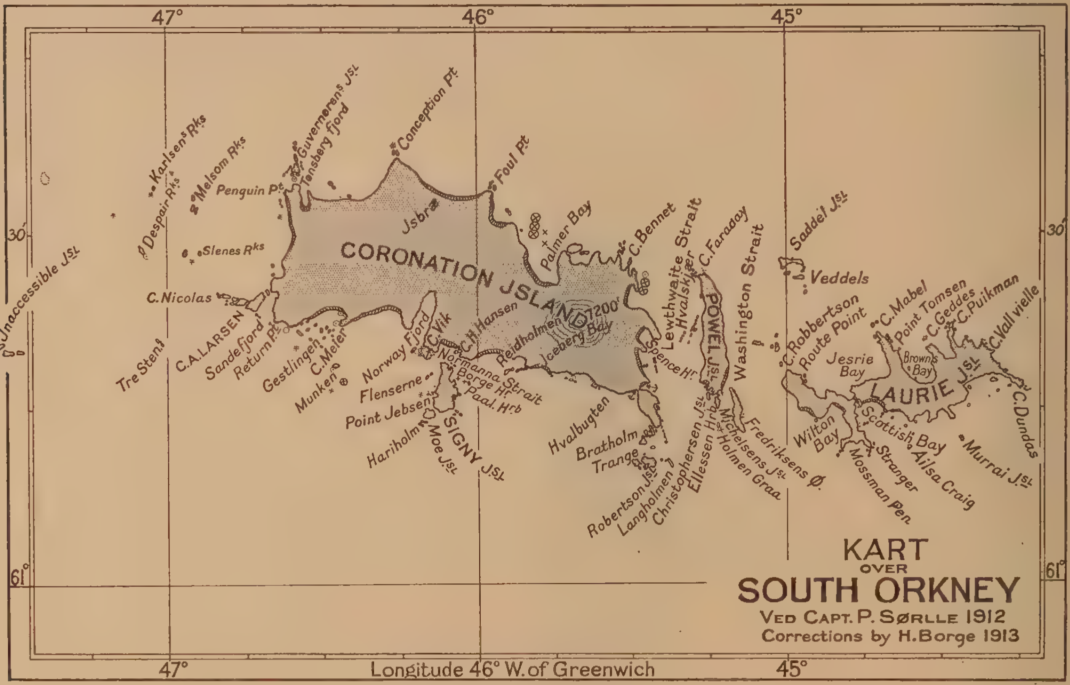
47°
46°
45°
30'
61°
Jnaccessible JSL
Karlsens Rks
Despair Rks
Melsom Rks
Penguin Pt
Guvernørens JSL
Tønsberg fjord
Conception Pt
Foul Pt
Slenes Rks
Jsbræ
CORONATION JSLAND
Palmer Bay
C.Bennet
C.Nicolas
Tre Stene
C.A.LARSEN
Sandefjord
Return Pt
Gestlingen
C.Meier
Munken
Norway Fjord
C.Vik
C.H.Hansen
Reidholmen
7200'
Iceberg Bay
Flenserne
Point Jebsen
Normanna Strait
Borge Hr
Paal Hrb
Hariholm
Moe JSL
SIGNY JSL
Hvalbugten
Bratholm
Trange
Robertson JSL
Langholmen
Christophersen JSL
Ellessen Hrb
Spence Hr
Lewthwaite Strait
Hvalskjær
C.Faraday
POWEL JSL
Washington Strait
Michelsens JSL
Holmen Graa
Fredriksens Ø
Saddel JSL
Veddels
C.Robbertson
Route Point
C.Mabel
Point Tomsen
C.Geddes
C.Puikman
C.Vallvielle
Jesrie Bay
Browns Bay
LAURIE JSL
Wilton Bay
Scottish Bay
Mossman Pen
Stranger
Ailsa Craig
Murrai JSL
C.Dundas
KART
OVER
SOUTH ORKNEY
VED CAPT. P. SØRLLE 1912
Corrections by H.Borge 1913
47°
Longitude 46° W.of Greenwich
45°

Fig. 9. The Norwegian Chart: after a reproduction of the original by Petter Sörlle, the actual figure being taken from a print kindly supplied by The Association of Whaling Companies, Sandefjord.

a good base by the whalers, is entered by a narrow passage foul on either side and consequently difficult for large ships to negotiate. The 'Falkland' was very badly damaged while trying to enter this harbour during the season 1912–13. It was much frequented, however, by the smaller whale-catchers for watering. Certain roadsteads, too, have been used as bases: in the season 1912–13 the 'Thule' anchored in Normanna Strait between Signy Island and Coronation Island, and in the same season the 'Tioga' found shelter inside Jebsen Rocks on the west coast of Signy Island, on which she drove ashore in a gale and was wrecked. The wreck was still lying there when the R.R.S. 'Discovery II' visited the island twenty years afterwards in January 1933, and on being boarded was found to have been stripped of everything that could be taken away including the bearings of the winches.

THE WORK OF THE VESSELS OF THE DISCOVERY COMMITTEE

Before passing to the description of the most recent hydrographic survey of the South Orkneys, that of the R.R.S. 'Discovery II' in January 1933, it is necessary to give a short summary of what has already been accomplished there, in surveying as well as in other scientific work, by the vessels of the Discovery Committee during their earlier voyages in southern waters.

On February 4, 1927, the R.R.S. 'Discovery', the famous auxiliary barque then employed by the Discovery Committee, sailed from South Georgia for the South Orkneys, and after a rough passage sighted the land on the 16th, entered Borge Bay the following evening and moored alongside the floating factory 'Orwell' for whom she carried mails. She sailed again early on the 20th for Deception Island and the Palmer Archipelago. In the short time at his disposal Lieutenant-Commander J. M. Chaplin, R.N.,[1] then Chief Officer of the 'Discovery', made a sextant triangulation of Borge Bay and from astronomical observations obtained on shore demonstrated that the whole group was charted fifteen miles too far to the westward. In the neighbourhood of Signy Island several hauls with the otter trawl, beam trawl and dredge were made in depths ranging from 20 to 340 m., and at Paal Harbour Microdrilid earthworms were discovered, apparently the first ever recorded from the group.[2] In working on the rich inshore bottom fauna of this region the 'Discovery' extended into deeper water the observations of the 'Scotia', which were confined for the most part to much shallower water (10–27 m.) near her winter anchorage in Scotia Bay.[3]

Towards the end of her first commission, 1929–31, the R.R.S. 'Discovery II' attempted twice to make a running survey of the South Orkneys, on each occasion being frustrated by those persistent enemies of the surveyor in this part of the Antarctic, pack-ice and thick weather. In December 1930, when the first attempt was made, ice invested the group and its coasts were unapproachable. The 'Discovery II' continued her voyage to the South Shetlands and the Bellingshausen Sea, and on her return from that cruise in February 1931 again visited the South Orkneys in the hope of finding them sufficiently free of ice and fog to allow of a survey to be made. This hope was unfulfilled. The pack was up to Signy Island and although the ship waited for four days (February 14–17) in Sandefjord Bay, neither sun nor stars made their appearance owing to the persistent fog and mist which hung over the land. In the meantime the pack had been steadily approaching from the southward and was already nearly up to Sandefjord Bay by the time the 'Discovery II' sailed. Sights were now obtained at sea and certain positions at the western end of Coronation Island and along the northern side of the group as far as the eastern end of Laurie Island were fixed by running survey and solar observations, notably Return Point, Conception and Foul Points, the centres of Powell and Saddle Islands and Cape Dundas. Although these observations were carried out under conditions that were far from favourable the position then assigned to Cape Dundas agrees very closely with the most recent determinations.

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[1] Chaplin, J. M., 1932, *Narrative of Hydrographic Survey Operations in South Georgia and the South Shetland Islands*, Discovery Reports, III, p. 301, Chart No. 4.

[2] Stephenson, J., 1932, *Oligochaeta, Part I, Microdrili (mainly Enchytraeidae)*, Discovery Reports, IV, p. 235.

[3] Bruce, W. S., 1918, *Zoological Log*, Scientific Results of the 'Scotia' 1902–4, IV, part I, pp. 1–101.

THE RECENT SURVEY OF THE ISLANDS

In the spring and early summer of 1932 the R.R.S. 'Discovery II' was occupied in making a chemical and biological survey of the waters of the Falkland sector of the Antarctic, a survey similar to that made a year before and described recently by Mr D. D. John in the *Geographical Journal* for May 1934. The edge of the pack-ice, wherever it might lie, constituted the southern limit of these investigations.

In middle and often in late spring the ice lies to the north of the South Shetlands and the South Orkneys. Towards the end of October the Bransfield Strait is still firmly blocked and as a rule a partial congestion continues there throughout November. The northern side of the South Shetlands, however, is often clear during this month, but farther east the South Orkneys, although lying nearly 100 miles north of the latitude of the main South Shetland Archipelago, are almost invariably enveloped on all sides and consequently unapproachable. In the late spring of 1932 the ice-edge, from about 80° W to the neighbourhood of the South Orkneys, lay unusually far to the southward. While operating the first north and south line of our survey we crossed the Antarctic Circle in the eightieth meridian during the last days of October and met the pack in about 68° S. Soon afterwards the Bransfield Strait was found to be completely ice-free in the first week of November, and later, on November 22, as we approached the South Orkneys along the forty-fifth meridian we were surprised to find that Laurie Island was also clear of pack at such an early date. For the moment our original programme was abandoned and the 'Discovery II' anchored in Scotia Bay in order to take advantage of the opportunity that these exceptional conditions offered for hydrographic survey. The weather being favourable the magnetic variation was determined, and a solar position obtained on shore that differed only slightly—by 0·8 mile south and 1·8 miles east—from that already determined by Bruce. On the evening of November 22 the staff of the Argentine Meteorological Station came on board to dine, and on their departure were presented with potatoes and fresh beef, of which they were much in need. Another day, November 23, was spent here in the hope of obtaining further observations, but the weather was thick and nothing more could be done. We sailed on the 24th in order to complete our interrupted line of observations to the ice-edge, which was met that day seventy miles due south of Scotia Bay. The oceanographical programme was brought to a conclusion with our arrival at South Georgia shortly before Christmas, and on December 29 we sailed from Grytviken with the object of making a running survey of the South Orkneys. We arrived at Scotia Bay early on the morning of January 2, and the work was begun that afternoon.

The method of the running survey is so well known that it hardly needs description here. It is perhaps well to remember, as Kemp[1] has remarked, that although it is one of the least accurate, in the hands of skilled observers it can yield excellent results; in view of the rapidity with which it can be carried through, it is by far the most practicable method of surveying distant and frequently inaccessible Antarctic islands. On the other hand surveying by triangulation, which is essentially a land operation, would be largely impracticable, for landings are difficult and often impossible, and the time involved would be so great that the charting even of such a small group as that of the South Orkneys might take many years to accomplish. For a research vessel like the 'Discovery II', unable to devote long periods to hydrographic surveying, it would be difficult to justify any other method than running survey. More often than not these islands are surrounded by ice or hidden by dense fog and it is only on rare occasions, like the fortunate chance that occurred in 1930 at the South Sandwich group, that conditions of weather and ice are such that the surveyor may set to work without the prospect of serious interruption. He must therefore, if he is to accomplish anything, not only seize every opportunity that is presented but work with all reasonable speed, for such favourable conditions may well be of the briefest duration and may not arise again for a long time. For the moment, then, the running survey must suffice. If handled with due care and with a sufficient number of land fixes there is no doubt that it will yield accurate results of great value to the whalers and explorers who frequent the Southern Ocean.

The month of January 1933 from the hydrographic standpoint was happily chosen, for the early promise of November was now amply fulfilled, the group being completely ice-free, and in the absence of any serious obstruction at sea the work of survey was pushed forward rapidly. It was midsummer, when the hours of daylight are at their maximum, and on several occasions throughout the month calm clear days occurred, accompanied by brilliant sunshine; in this we were exceptionally fortunate, for in summer at the South Orkneys the sky is apt to be overcast and the land shrouded in fog. With such excellent conditions the work of charting was much easier than it might otherwise have been, and in addition we obtained a comprehensive series of coastal photographs from many parts of the group, more especially from Coronation Island, the adjoining islands of Powell and Signy, the Inaccessible Islands and other outlying and comparatively little-known rocks and islets. Throughout our visit exceptionally large numbers of icebergs were encountered in the neighbourhood of the islands. Within twenty miles of the southern shores at least 1500 were present in the early part of the month, a considerable number of them being heavily concentrated around the southern approaches to Lewthwaite and Washington Straits. Had the weather been continuously thick they might well have constituted a serious obstacle to our movements and to the rapid progress of the survey, but in the clear conditions that we experienced we suffered but little inconvenience from them, although on occasion they lay so thickly across our path as to cut out the southern horizon (see Plate XIV, fig. 3).

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[1] Kemp, S., 1932, *The Voyage of the R.R.S. 'Discovery II': Surveys and Soundings*, Geog. Journ., LXXIX, 3, pp. 168–9.

Throughout the survey temperatures were high, rarely falling below 30° F. and rising to a maximum of 52° F. in Borge Bay on January 17, the average temperature of that day from midnight to midnight being 44·1° F. The average temperature throughout the period of our visit was 33·9° F.

The survey, under the direction of the late Commander W. M. Carey, R.N. (Retd.), was carried out by Lieutenant A. L. Nelson, R.N.R., then Chief Officer and Navigator, now Master, of the 'Discovery II'. Lieutenant Nelson had already had experience in work of this kind in other Dependencies of the Falkland Islands, and it is to his energy and enthusiasm that such success as we achieved at the South Orkneys is primarily due. In the exacting work of conning the vessel close inshore he had the co-operation of an energetic executive staff, and the whole-hearted support of the ship's company.

A large number of echo-soundings were taken and the working of the sounding machines throughout owes much to the supervision of the Chief Engineer, Lieutenant-Commander W. A. Horton, R.N. (Retd.) and his staff, and to the care bestowed on them by the technical assistant, Mr R. S. Veitch, whose charge they were. Both sounding machines, the shallow and the deep, worked reasonably well; the shallow one occasionally broke down, but this is scarcely surprising since we were constantly sounding in shallow water and it was subjected to exceptionally heavy use. We were never actually unable to get soundings, however, since the deep machine, though less efficient in very shallow water, could always be used. The soundings were carried out by the scientific staff under Mr D. D. John and by the surgeon, Dr G. M. Gibbon. The photographs which accompany this report are the work of the laboratory assistant, Mr A. Saunders.

The survey was completed in twenty-eight days, January 2–29. Of this period only twelve days were actually employed in working round the main coasts of the group, the remaining sixteen from time to time being spent at anchor, sometimes through stress of weather, sometimes in order to make more detailed plans of certain of the harbours or anchorages in which we took shelter. During the twelve days in question we ran along and surveyed the coasts of the entire group and charted besides the multitude of smaller islands, islets and rocks which form part of the group. Signy Island, because its coast on the whole provides better anchorage than elsewhere, was surveyed on a larger scale than the others. A constant look-out was kept for the less obvious and therefore more dangerous obstacles to navigation which from time to time have been reported or charted by whalers, obstacles such as small isolated rocks situated far off the main coasts, sunken reefs or shoal patches; and although on occasion we engaged in a fruitless search, the positions of those that were found were accurately determined. The waters surrounding the group were sounded by our echo machines, special attention being given to straits and narrow passages and the approaches to harbours. We entered and sounded in most of the bays which occur profusely throughout the group. In narrow waters and when close inshore, we sounded every minute or every two minutes, and even in deeper water farther off the land the interval between observations rarely exceeded five minutes. In all about 2250 soundings were made. Once or twice exceedingly narrow channels between off-lying islets and the mainland were carefully sounded and proved to be navigable by the obvious and satisfactory method of steaming slowly through them. Our speed while surveying was slow, rather less than three knots, and as a rule we kept as close inshore as possible, being often little more than two or three cables off the land.

The heights of the smaller islands, of the islets and rocks as well as of all prominent features along the coasts we surveyed, were fixed *en route* from the ship. On the rare occasions when it was possible to climb, the altitudes of a few of the lower and more accessible peaks on Coronation, Laurie, Powell and Signy Islands were determined by aneroid. None of the greater peaks was climbed. Their ascent, although practicable, presents considerable technical difficulties, especially on Coronation Island, and in any case would have required much preparation and more time than we could have spared. Once, when the ship was anchored in Borge Bay, we set out by whaler with the object of climbing a considerable peak on Coronation Island, but when we had crossed Normanna Strait heavy mist came down, hiding the high land, and although we went ashore and did some work on the coast while waiting for conditions to improve our time was limited, and we were compelled to return to the ship without having attempted our objective. The heights of a number of these peaks, however, were fixed from the sea whenever the summer mist lifted and left their summits clear.

Although we took full advantage of the daylight hours as long as the weather was clear, it was essential for the safety of the vessel that work should cease while there was yet enough light to find a harbour where she could be securely moored before darkness set in. As a rule we anchored about 8 p.m. and got under way shortly before nine in the morning—sometimes earlier if the weather was exceptionally fine, or later if it failed to clear—and work continued throughout the day until evening, when as the light began to fail we sought shelter again for the night. In a short time we became acquainted with all the better-known harbours of the group, Scotia Bay, Uruguay Cove, Ellefsen Harbour, Borge Bay and Sandefjord Bay, and with several less frequented anchorages such as Wilton Bay, Brown Bay, the western approach to Sandefjord Bay, and others.

The sixteen days during which we lay at anchor were by no means unproductive. Much of the time was occupied in obtaining the necessary observations for land fixes, in plotting and working up the heavy accumulation of earlier observations that they might be linked up later with the rest of the survey, and in making detailed plans of certain of the harbours themselves.

Positions were fixed on land by solar observations at Scotia Bay, Christoffersen Island, Borge Bay and Sandefjord Bay. With these fixed points all other observations were linked up. All four were fixed by sextant and artificial horizon, two sextants being so employed that each set of observations was in duplicate.

Three of the more important harbours, those of Borge Bay, Ellefsen and Sandefjord, were surveyed and sounded. In the absence of triangulation various other means were employed in achieving this end, means which if somewhat unorthodox were amply justified in view of the despatch with which the work had to be carried through. Much was done in the following manner: the ship was moored with both cables hove taut, and upon the fixed point thus provided by her bow bearings and ranges were obtained from all important points on the shore. In conjunction with other means this method was employed in all three harbours surveyed. The whalers were mainly used for sounding, but one of them, provided with a boat's compass and a small rangefinder and manned by experienced oarsmen, was occasionally used for actual coastal work in the harbours when other means were impracticable. The distance traversed was determined by the length of stroke, which had been carefully calculated over a known distance. This method was employed with good results in surveying the coast of Christoffersen Island, a small island flanking Ellefsen Harbour in the west, as well as in certain parts of Borge Bay where the ship's motor-boat with yacht log and compass was also employed. The motor-boat, however, had to be run fast and for this reason was less satisfactory than the slower whaler. Ellefsen Harbour was triangulated from a base 740 feet in length, measured by using the stadia lines on the level and the levelling stave, while Michelsen Island, the eastern side of Ellefsen Harbour, was walked round with a boat's compass and small rangefinder, a flag on a staff being sent on ahead. Christoffersen Island, being steep and impassable, was surveyed from a whaler in the manner already described. In sounding the harbours the bow was again used as a fixed point from which those working on the whalers, observing frequent horizontal and masthead angles, ran lines to other points on shore indicated by beacons or flags. No tidal observations were made and the soundings accordingly are not reduced. The extent of the rise and fall, however, is such that corrections to soundings of six fathoms or over are for all practical purposes unnecessary.

While the surveyors were thus employed members of the scientific staff landed on various points of the group, and plants, animals and rocks were gathered from seven widely separated places, the majority hitherto untrodden by collectors. Very little geological work has been done at the South Orkneys since the days of the Scottish expedition, whose observations were largely confined to Laurie Island. To the best of our knowledge the islands to the westward, Fredriksen and Powell Islands with their adjoining rocks and islets, Coronation Island, Signy Island and the Inaccessible Islands, on all of which we were able to land, have never been visited by a geologist, and the only rock specimens known from any of these islands prior to our visit appear to be those collected on Signy Island in the season 1927–8 by Captain S. Berntsen of the 'Orwell'.[1] We regretted the absence of a fully trained geologist, feeling that much might have been done with the opportunities that were presented. With our limited knowledge of geology we were often puzzled as to the best method of procedure. Nevertheless we made frequent if somewhat unprofessional notes, and collected as many different types of rocks from as many different localities as the exigencies of the survey would permit.

Acting on the advice of the Admiralty the R.R.S. 'Discovery II' in the course of her third commission was again instructed to visit the South Orkneys with the object of checking the position based on solar observations that had been assigned to the group in January 1933. She sailed from Port Stanley on March 27, 1934, and having spent some time on the way, working nets and taking water samples according to her usual routine, reached the South Orkneys at daylight on April 1 and anchored in Borge Bay, Signy Island. Although all was made ready no sights were obtained that day. The sun appeared momentarily at noon but observations were impracticable on account of its low altitude. No stars came out at night. The following morning the ship sailed for Laurie Island in the hope of finding better conditions there. Running soundings, she proceeded towards South Cape, meeting with some ice on the way. On opening the straits both were found to be blocked by fairly heavy ice, and as it appeared likely that Scotia Bay and Uruguay Cove would be similarly blocked she returned to Borge Bay and anchored. The sky cleared that evening and the Captain, Lieutenant A. L. Nelson, R.N.R., obtained a round of stellar sights, observing stars at north-east, south-east, south-west and north-west. The latitude of Borge Bay was determined as 32·76″ south of that previously assigned, but the longitude (45° 35′ 35″ W) was practically the same. The 'Discovery II' sailed from Borge Bay about noon on the 3rd and ran soundings through Normanna Strait; but as it was now blowing a gale from the northward she took shelter for the night in Sandefjord Bay. At daylight on the following day it was so thick that the poop was barely visible from the bridge, but at 8 a.m., the visibility having improved to about three cables, she weighed and proceeded through the Narrows to the north. Continuing her way to South Georgia, she anchored in Grytviken on April 10.

As one result of our work it is satisfactory to record that we have been able to confirm the thoroughness and accuracy of the Scottish triangulation of Laurie Island, which was carried out during the winter and spring of 1903 under conditions of unusual severity. Here and there a few extra rocks have been charted around its coast, rocks that may well have been overlooked in the winter of 1903 owing to the pack-ice which invested the island, and the slight gaps in Bruce's coast-line on Mackenzie and Pirie Peninsulas have now been filled in; but little else, apart from our numerous echo soundings, has been added to the existing chart by Bruce. On the other hand the position of Captain Sörlle's Coronation Island has been adjusted and its outline, largely owing to a general reduction in width, has been somewhat altered, although in a measure it still retains the general appearance given it in the Norwegian chart. To the charts of last century our chart of Coronation Island bears scarcely any resemblance at all. Prior to 1925 the shape of Coronation Island, based on the French survey of 1838 had remained unaltered in the British Admiralty charts for more than eighty years. There it appears as a vaguely oblong mass of land rather less than thirty-five miles in length, and except for a narrow part between Palmer's Bay and Iceberg Bay some six or seven miles across, of a fairly uniform width of from twelve to fifteen miles. It is broadest towards the west where it is at least fourteen miles across. The coast-line, like that of Laurie Island until Bruce revealed its remarkable irregularity in 1903, appeared neither arresting in outline nor characterized by deep indentations with the possible exception of Spence's Harbour and Palmer's Bay. In the Norwegian chart which lately superseded the others the island begins to assume an irregularity of form that is perhaps not surprising in view of the remarkable outline of its eastern neighbour. Along the hitherto almost unknown south coast deep indentations appear, which, running northwards into the land, greatly reduce the average width of the island, especially at its western end which is shown as only some eight to nine miles across. Nevertheless our recent survey (Chart I) reveals the fact that Coronation Island is even more irregular in form and generally narrower and more elongate than Sörlle had supposed. Indeed at its western end, where as we have seen the width was reduced by Sörlle from some fourteen to eight miles, there actually exists an extremely narrow neck 3·2 miles in width. In its present form Coronation Island begins to assume, as never before, the appearance of a "drowned" or sunken land, an impression so strongly conveyed by the parallel-sided fiord-like bays of Laurie Island.

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[1] See Holtedahl, O., 1929, *On the Geology and Physiography of some Antarctic and Sub-antarctic Islands*, Scientific Results of the Norwegian Antarctic Expeditions, 1927–8 and 1928–9, No. 3, p. 99 (Oslo).

DESCRIPTION OF THE ISLANDS

The South Orkneys, a mountainous and rugged group, lie between the parallels 60° and 61° S, and between the meridians 44° and 47° W. They occur far to the north of the Antarctic Circle. Nevertheless, in view of the harshness of their climate, the paucity of their vegetation, and the degree of their glaciation, they are strictly Antarctic in character. They are a small and somewhat isolated group (Fig. 10) lying 454 miles south-west of South Georgia and 293 miles north-east of the northern tip of Graham Land. Their nearest neighbour is Clarence Island, from which they are separated by 173 miles of open sea. The group on the whole is a compact one, the major islands which compose it being separated from each other by narrow straits at most a mile or two across. It consists of two large islands, Coronation Island in the west and Laurie Island in the east, two smaller although still considerable islands, Powell and Signy, together with a large number of very small islands, islets and rocks (Chart I). Some of the latter, in particular the Inaccessible Islands, lie at a comparatively great distance from the main mass of the group. The gap between Coronation Island and Laurie Island is 9·5 miles in width. Almost in the middle of it, with its main axis running north and south, is the long and narrow Powell Island. Coronation and Laurie Islands are thus separated from each other by two narrow parallel straits, Washington in the east and Lewthwaite in the west. Signy Island lies half-way along the south coast of Coronation Island and is separated from the latter by a narrow passage, Normanna Strait. Although the outline of the group as a whole is most irregular and its coasts deeply indented by bays of considerable size, it possesses a well-defined long axis, trending in Coronation Island, in an east-south-east and west-north-west direction, in Laurie Island, almost due east and west. From Cape Dundas, in the extreme east of Laurie Island, to the Inaccessible Islands, the extreme westerly limit of the group, the distance is 68 miles. From north to south it is very much less, Coronation Island, the largest of the group, even at its broadest point being scarcely eight miles across. With the exception of Signy all the larger islands are extensively ice-clad, and in this as in other respects the group may perhaps be considered to be more truly Antarctic in character than the South Shetlands which lie considerably farther to the south.

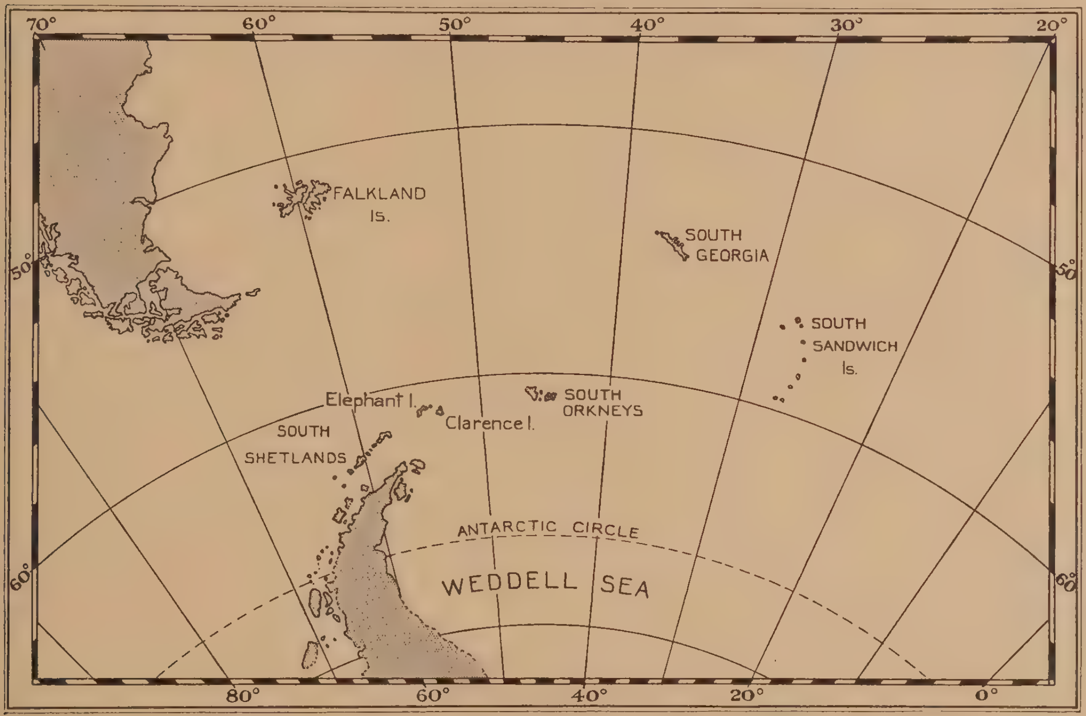

Fig. 10. The Falkland Islands and their Dependencies.

Lying near the Weddell Sea, the South Orkneys become involved annually in the general winter freeze-up of the Antarctic Ocean and in consequence are only accessible to shipping for a short period during the summer.

On their north side the South Orkneys rise suddenly out of deep water. In Herdman's bathymetric chart[1] depths of over 5000 m. occur within twenty miles of the northern shores, the 250–2000 m. isobaths being closely crowded together within only a few miles of Saddle Island and Conception Point. On the other hand the bathymetric gradient on the south side appears to be a gentle one, and although the area as yet has been little sounded, there are indications that great depths such as are encountered so quickly in the north do not occur within a hundred miles of the southern shores. On the evidence of a few scattered soundings by the 'Scotia' and the 'Discovery' and some echo soundings by the 'Discovery II' Herdman has shown provisionally that shallow water of less than 1000 m. in depth extends approximately for thirty-five miles to the south-west, thirty miles to the south, and as much as ninety miles to the south-east of the group. More recent soundings, however, which have not yet been placed upon the chart, would seem to indicate that the bathymetric gradient at least to the south of Laurie Island is even gentler than Herdman supposed. On November 22, 1932, the 'Discovery II' sounded continuously in shallow water for a long way to the southwards and was still in soundings of less than 500 m. when eventually held up by pack-ice seventy miles due south of Scotia Bay. It would also appear that the extension of the coastal shelf to the south-eastwards of the group, first demonstrated by Bruce[1] some thirty years ago, swings round to the west and is considerably larger in area than has hitherto been supposed. From the available soundings it is therefore evident that a considerable area of shallow water extends for a relatively great distance to the south and south-east of Laurie Island. Still farther to the southward there is presumably a fairly abrupt descent to the floor of the Weddell Sea, but the nature of the slope is unknown since the area under consideration is usually heavily covered with pack-ice and has not yet been examined.

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[1] Herdman, H. F. P., 1932, *Report on Soundings taken during the Discovery Investigations*, 1926–32, Discovery Reports, VI, pp. 205–36, pl. XLV.

With the exception of Signy, the islands on the whole rise abruptly from the sea by irregular ridges and sharp peaks to the crest of a mountain chain or central ridge of very variable height, which running from east to west forms the backbone of the group. The central ridge attains its maximum height at the eastern end of Coronation Island, where it rises above 3000 feet. The coasts in general are precipitous and rugged to a degree. In some parts of the group, however, notably in the north and north-west of Coronation Island, there is comparatively low-lying land adjoining the sea, of a fairly easy gradient and covered smoothly by a thin, almost continuous mantle of ice (Plate XVIII, fig. 1). Elsewhere the mountains descend to the sea in precipitous slopes and by sharp rocky ridges, terminating in bold headlands or in sheer buttresses and ice slopes of varying declivity (Plates XV, XVI, XX). The coast-line is broken at frequent intervals by the cliff fronts of short glaciers of a type common to the more northerly Antarctic lands of the Falkland Dependencies and exceedingly numerous at the South Orkneys, where they fill every valley and depression opening on to the sea from the heights above.[2] They occur typically as low platforms in the otherwise lofty coast, between the rock ridges and steep bluffs that plunge directly into the sea. Near the shore-line their slope to the sea is a gentle one, but in the rear they soon curve rapidly upwards by smooth slopes towards the crest of the central ridge against which they appear to be heaped, as it were, like great masses of drifted snow. They are more or less dormant; for unlike many other glaciers they are not fed continuously nor are they continuously being pushed towards the sea by the downward and outward pressure of a heavy inland ice-sheet. No such ice-sheet exists in the South Orkneys: wherever the heights above are crowned with ice the covering is so thin that it fails altogether to mask the irregularities of the underlying rock, and it is spread so evenly and lightly over the high land that it can exercise only the slightest influence on the fringing platforms below.

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[1] Bruce, W. S., 1905, *Bathymetric Survey of the South Atlantic Ocean and Weddell Sea*, Scott. Geog. Mag., XXI, No. VIII, pp. 404–8.

[2] These are the so-called "ice-foot" glaciers of Nordenskjöld. They are discussed in greater detail below, pp. 360 and 364–5.

Other than in the ice-filled depressions and in such almost completely ice-covered areas as exist in the north and north-west of Coronation Island there is little low-lying land and little of gentle gradient. Here and there an acre or two of almost level ice-free ground may be found at sea-level or as a diminutive plateau or step on the lower coastal slopes, but these are of rare occurrence and confined almost entirely to Laurie and Signy Islands. On Coronation Island there are practically none.

There is much ice-free rock, not only on the coastal buttresses, slopes, and descending ridges but in the higher interior as well, wherever the mountains rear themselves in sharp pinnacles above the general level of the ice-filled valleys, and in general wherever the land is too steep or windswept to retain snow for any long period. From the sea the bare rock appears very dark, almost black, against the ice. In mid-winter practically all is hidden by snow, even the coastal precipices and high pinnacles in the interior.

Although nearly all the descriptions of last century, and not a few of later date, are concerned largely with their barren and forbidding aspect, the South Orkneys can in bright sunshine present a spectacle that is both grand and beautiful (Plates XV, XVI). Even Fanning, vague and second-hand as his story is, seems to have grasped this fact, for the impression he conveys of the South Orkneys contrasts strangely with the somewhat unfavourable and gloomy descriptions of his contemporaries, Powell and Weddell. "The valleys and gulleys" he remarks "were mainly filled with those never dissolved icebergs, their square and perpendicular fronts several hundred feet in height, glistening most splendidly in a variety of colors as the sun shone upon them. The mountains on the coast, as well as those to all appearance in the interior, were generally covered with snow, except when their black peaks were seen here and there peeping out."[1]

Owing to the precipitous nature of the rocks and slopes that reach the sea a general traverse of the coasts by sledge, although no doubt fairly simple in parts, would as a whole be a matter of great difficulty if not altogether impossible: for although the surfaces of the glaciers and easier ice-slopes bordering the sea are on the whole good enough and safe enough, and withal flat enough for travelling, communication between one smooth ice area and another is often completely cut off by some intervening buttress of sheer rock or by an ice-slope too steep to negotiate. The 'Scotia's' surveying parties experienced the greatest difficulty in traversing the coast of Laurie Island by sledge in the winter and spring of 1903[2] and for the most part were forced to take to the sea-ice; nor did their troubles cease there, for owing to a mild winter the pack-ice never became really consolidated but kept shifting about so that their route was often a perilous one. In colder winters when the floes as a rule are firmly frozen and immovable for a considerable distance around the group, communication with all parts could no doubt be established over the sea-ice. Mossman, who experienced the mild winter of 1903 as well as the rigours of the hard winter that followed, writes of the latter: "This season all would have been different: the weather was remarkably fine for days together, and the survey of Coronation Island, an impossibility last winter [1903] owing to the disturbed ice conditions, would not only have been practicable but easy."[1] It should further be noted that although the route by the coast is fraught with obstacles, access to the high interior, *athwart the long axis of the group*, may be had at many points both on Coronation Island and Laurie Island by way of the glacier-filled depressions or gentler ice-slopes.

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[1] Fanning, E., *loc. cit.*, *supra*, p. 440.

[2] *The Voyage of the 'Scotia'*, pp. 76 and 145–57.

Little of what has just been said, however, can be applied to Signy Island, because it is comparatively ice-free, not very high, and possesses little of the rugged profile which characterizes the group as a whole. There is far more level and low-lying ground than in any other part of the group and the island may be traversed in all directions with little difficulty.

Fricker,[2] basing his calculations on the crude maps of last century, estimated that the area of Coronation Island was 560–625 square miles, and that of Laurie Island 235–312 square miles. Recent calculations, however, based on the chart which we made, place the area of Coronation Island at about 130, and that of Laurie Island at about 25 square miles, while the total area of the group is estimated to be in the neighbourhood of 175 square miles.

In the spring innumerable sea birds come to the islands to nest and breed. They remain throughout the summer until autumn, scouring the surrounding seas for their food. They are largely petrels of several kinds, and penguins. The latter to the number of several millions occupy every available rocky site along the ice-bound coasts, filling the air with tumult and trampling to extinction the scanty sea-board flora in the mud and garbage of their rookeries. Seals of the several Antarctic species are scattered around the coasts in moderate numbers from spring to autumn, sometimes congregated on the fast ice which still lingers beyond the ice-foot in summer, sometimes in small rookeries on one or other of the rare South Orkney beaches, but generally in twos or threes or singly, on rocky shelves or on the stranded fragments from glacier cliffs and disrupting icebergs. With the approach of winter, when access to their food supply is blocked or largely curtailed by pack-ice, the birds and seals desert the islands and disperse to more open water in the north. Under exceptional conditions the migration of the penguins may be of such a fleeting nature that it may hardly be said to take place at all. In 1908, according to Mossman,[3] no pack-ice was seen in the neighbourhood of the

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[1] *The Voyage of the 'Scotia'*, p. 336.

[2] Fricker, K., 1900, *The Antarctic Regions*, Sonnenschein's translation, pp. 153–5 (London).

[3] Mossman, R. C., 1909, *Meteorology at the South Orkneys and South Georgia in* 1908, Scott. Geog. Mag., xxv, No. 8, p. 409.

South Orkneys, and except for a few weeks in July and August when the sea froze smoothly over, the islands were surrounded by open water. As a result of this abnormally open winter the penguins were seen practically all the year round except in the month of July. An account of the birds of the South Orkneys, which is shortly to be published, has been written by Lieutenant R. A. B. Ardley, R.N.R., formerly Second Officer of the 'Discovery II'. The seals will be dealt with later in this report (see pp. 370–8).

Land invertebrates, rich in numbers but poor in species, are found everywhere along the ice-free coastal belt. Apart from such minute fresh-water forms as Nematodes, Tardigrades and the like by far the most important is a Collembolan (see Appendix I, p. 379) which occurs in enormous numbers low down near the sea and in rapidly decreasing numbers up to heights of about 600 feet. There are also two or three species of mites, one of which is exceedingly abundant near the sea. Microdrilid earthworms of the family Enchytraeidae, which are commonly found on the beaches of South Georgia, appear to be very rare at the South Orkneys. There is only one record of their occurrence, at Paal Harbour in Signy Island (see above, p. 327). None was found in January 1933.

Food fishes, Nototheniids of several kinds, are said to be readily obtainable; even when the islands are ice-bound they can be caught by means of lines or traps lowered through holes in the ice kept open for the purpose.[1] During our recent visit, however, although traps were set in various parts of the group, we met with signal failure, rarely if ever catching more than one at a time.

APPROACHES, HARBOURS AND TIDES

Approaches. In the past the position of the South Orkneys was much in doubt and their charting inadequate. It is therefore not surprising that, surrounded as they are by icebergs and generally shrouded in fog, navigators should have been warned to proceed with caution when approaching them. With the publication of the new chart the chief of the several hazards that formerly beset the approach to the South Orkneys has been removed, and we may now say with Powell's editor, but with far more reason, that "the navigation of this gloomy region, now more clearly developed, is freed from half of its dangers".[2] The fog and the icebergs remain, and of these the first is and will continue to be by far the most irksome and troublesome element with which vessels in these waters have to contend. In exceptionally clear conditions the South Orkneys may be seen from a distance of sixty miles. Nearer at hand Saddle Island, lying somewhat apart from the rest of the group, about five and a half miles due north of the western end of Laurie Island, from the peculiar shape of its double summit serves as an exceptionally good landmark, especially for vessels approaching from the north, north-west, or west. As a rule, however, low mists hang over the islands, hiding all useful landmarks except for a few hundred feet of almost featureless sea-board, or blotting out the land altogether. Fog, although often local, may extend for a long way beyond the immediate neighbourhood of the land, so that vessels may be compelled to approach the coast on dead reckoning alone. In these circumstances it is well to remember that an easterly set of from a half to one and a half knots may generally be encountered along the northern side of the group. Scattered about the islands in all directions there are usually large numbers of stranded icebergs, which while unpleasant to meet in thick weather, give some indication of the nearness of the land, especially in the north, where any that go aground must do so within a few miles of the shore owing to the extreme narrowness of the continental shelf. On the other hand, kelp (*Macrocystis pyrifera*), which is plentiful at South Georgia and upon which the whalers mainly depend for guidance while groping their way into harbour in dense fog, appears to be rare at the South Orkneys or absent altogether (see p. 368).

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[1] See *The Voyage of the 'Scotia'*, pp. 91, 328, and Bruce, W. S., 1911, *Polar Exploration*, p. 155 (London).

[2] Powell, G., 1822, *loc. cit.*, p. 3.

Icebergs are troublesome in fog, and as they are exceedingly numerous at the South Orkneys one might well be inclined to think that navigation in the immediate neighbourhood of the group would be attended, for steel ships at least, by almost unwarrantable risks. Actually, their very abundance is in itself a safeguard, for not only does a large concourse of bergs break the force of wind and wave and so tend to produce comparative calm in an otherwise turbulent sea, but at the same time from sheer necessity navigators are compelled to exercise more than ordinary caution. They are sometimes encountered so densely crowded that even if the weather is clear it is exceedingly difficult and occasionally impossible to get sights or to obtain bearings of the land. Covering the sea in hundreds they present a barrier through which vessels must pass by a tortuous route, with little clearance, sometimes scarcely a boat's length, between the icebergs on either hand. Old and rotten bergs are a source of danger, since they may collapse or capsize, and stranded bergs in general should be given a berth wherever possible, for they sometimes mask the reefs or shoal patches on which they have gone aground.

Many rocks and breakers exist around the coasts, and although it is thought that most if not all have now been fixed and placed upon the chart, others may still exist. A close watch should be kept for covered rocks which do not always break, for in our experience these may have twenty to thirty fathoms of water close alongside, and vessels may come upon them suddenly and without warning. Against such hidden dangers the best safeguard is to have a look-out stationed on the foremast as high as possible, gazing directly ahead for signs of broken or discoloured water.

HARBOURS (see Plates XII, XIII, XIV, XIX). In most parts of the South Orkneys, anchorage with shelter from one quarter or another may be obtained, the three harbours which were surveyed by the 'Discovery II' being among the best, if not the best, in the group. None, however, is perfect, for one and all are subject to the visitation of ocean swells and pack-ice which may drive in almost at any time during the open season, and vessels may find it necessary to move to some other and less exposed quarter of the group. Borge Bay on the east coast of Signy Island is one of the best in the group and has been much frequented by whalers. Signy Island as a whole, although fringed with exposed and sunken rocks on the east, south, and west coasts in particular, possesses several good anchorages for large vessels which are easy of approach and with good holding ground; in one, if not in another, shelter can be obtained from almost any wind. Ellefsen, at the southern end of Powell Island, is an excellent little harbour. It is small, but the holding ground is good, and it is protected on three sides, by Powell Island in the north, Michelsen Island in the east, and Christoffersen Island in the west. It is exposed to the south, but sometimes, as in January 1933, it is protected against swells from that quarter by the large number of icebergs that may be stranded about its southern approach. Heavy weather from the south is, however, comparatively rare, the strongest winds being from the west or south-west. The neighbouring Falkland Harbour is shallow and suitable only for small craft and its entrance is narrow and foul on either side; it used to be frequented by whale-catchers in the early days of whaling at the South Orkneys. Sandefjord Bay, at the south-western corner of Coronation Island, is a large and roomy harbour with good holding ground. The usual approach is from the south, which is exposed, but there is a second outlet in the north, the Narrows, barely 200 yards across and with a swift tide (see Chart I). There is yet another and narrower outlet to the east of the Narrows, between Spine Island and the mainland, which was not examined by the 'Discovery II'; according to Powell (see p. 295) the tide runs strongly through it and there is a sunken rock in the centre. Among other well-known anchorages at the South Orkneys neither Scotia Bay nor Uruguay Cove in Laurie Island are greatly to be recommended, although both have been used for a long time by the Argentine ships that visit the meteorological station. Both are exposed; of the two Uruguay Cove on the whole provides the better shelter, the adjacent anchorage at the head of Scotia Bay being very small and the holding ground indifferent. The former, however, is uncomfortable during gales from the north-north-east and north-west, when heavy seas drive in and break on the Beach, occasionally rendering it dangerous for vessels discharging stores for the station.[1]

Among other and less attractive anchorages are Gibbon Bay, Petters Bay and Spence Harbour on the east coast of Coronation Island, the western side of Norway Bight on the south coast, and some others. Although all are too open to afford any great protection and have comparatively deep water, they nevertheless provide useful temporary anchoring places. Similar shelter may be found in almost any of the deep bays running into the north and south coasts of Laurie Island. The north coast of Coronation Island on the other hand is far less deeply indented; it is inclined to be a lee shore, being exposed to much of the worst weather that visits the group.

The uncertain movements of the pack-ice in the northern bays (see p. 348) render them unsuitable as winter anchorages, and vessels intending to spend the winter at the South Orkneys should therefore seek the southern side of the group, where though they may expect to be frozen in for some months, there is less chance of their anchorage becoming insecure or dangerous through a sudden break-up of the ice followed by alternate driving in and out of the floes.

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[1] Yalour, J., *loc. cit.*, pp. 33–8.

TIDES. Between May and October 1903, tidal observations were carried out from the 'Scotia' as she lay frozen in in Scotia Bay. According to G. H. Darwin,[1] who examined the data thus collected, the tides of the South Orkneys seem to be normal for a place in the Southern Ocean. The semi-diurnal tides are considerable, but the solar tide is unusually large compared with the lunar tide. The semi-diurnal tides are almost exactly "inverted", so that low water occurs very nearly when the moon is on the meridian.

From the somewhat cursory observations made in January 1933, the rise and fall does not appear to be very great, at any rate not so great that correction need be applied to soundings of six fathoms or over. Powell records a rise of about six to eight feet in the Sandefjord Bay district and a slightly greater rise and fall, about ten feet, at Spence Harbour, adding that in the latter locality "the tides do not ebb and flow regularly: it sometimes remains low water for the whole day, at other times it keeps up for the same space of time". Through the straits and narrow channels the tides run strongly. Powell experienced a current of about three and a half knots in Lewthwaite and Washington Straits, while at Sandefjord Bay, in the narrow passage between Spine Island and the mainland, he records a flood tide of about four knots. The 'Discovery II' encountered a very strong tidal stream in the Narrows adjoining. Small bergs are generally carried on the tide and are often to be found streaming through Lewthwaite and Washington Straits with the current. They are inclined to hamper navigation in narrow waters. Tide rips are exceedingly common in the straits and in a lesser degree around the coasts in general. They are most noticeable when the weather is calm.

THE SCOTIA ARC[2]

The recent investigations of Herdman on the bottom relief of the Scotia Sea have established beyond doubt that a rise or submarine ridge extends eastwards from Tierra del Fuego through Staten Island, the Burdwood Bank, the Shag Rocks, South Georgia and the Clerke Rocks, to the volcanic arc of the South Sandwich Islands, and thence, sweeping round to the westward through the South Orkneys, eventually links up with Graham Land and the South Shetland Archipelago. In other words, if we accept the views of most geologists, the South Orkneys, together with the South Sandwich Islands, South Georgia and the rest, may be regarded as the unsubmerged remnants of a great eastwardly directed mountain loop which once connected the southern tip of the Andes with the mountains of Graham Land: for it has been shown that the latter are in many respects geologically identical with their Patagonian neighbours. Although the idea of a tectonic connection between Graham Land and Patagonia was of much earlier origin, it was not until 1909 that Suess[1] suggested that the lines of folding lay along the path of this island chain which, by analogy with a similar structure in the northern hemisphere, later writers have called the South Antillean Arc, a name recently superseded by the more appropriate if less familiar one of the Scotia Arc.[2] Suess's theory was contested on the grounds that the Andean affinities exhibited by the igneous rocks of Graham Land and the western portion of the South Shetlands were entirely lacking throughout the rest of the chain, and that no continuous submarine connection existed to link up the several islands which compose it; but the controversy that arose, although based on careful geological observation in many parts of the arc, was insufficiently supported by soundings, so that the argument on both sides was inconclusive. By the use of echo sounding machines, however, many further soundings have now been obtained, first by the 'Meteor' in 1925–6, and later, between 1930 and 1932, by the R.R.S. 'Discovery II'. As a result of these soundings, particularly those of the 'Discovery II' which ran to many thousands, Herdman was able to show that whatever their geological significance ridges exist throughout all the sectors of the arc and link up the land fragments of which it is composed.

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[1] Scientific results of the 'Scotia' 1902–4, II, p. 323.

[2] Recent and fuller accounts of the Scotia Arc problem and its history, to which the author is indebted, will be found in the Discovery Reports: Kemp, S., and Nelson, A. L., 1931, *The South Sandwich Islands*, with a Report on Rock Specimens by G. W. Tyrrell, III, pp. 148, 154–5, 191–7; Herdman, H. F. P., 1932, *Report on Soundings taken during the Discovery Investigations*, 1926–32, VI, pp. 214–29, plate XLV; Macfadyen, W. A., 1933, *Fossil Foraminifera from the Burdwood Bank and their Geological Significance*, VII, pp. 13–15; see also G. W. Tyrrell in *Report on the Geological Collections made during the Voyage of the 'Quest'*, British Museum (Natural History), 1930, pp. 51–4.

The submarine connection varies greatly in accentuation. It is least definite along the northern arm of the island loop in the big oceanic gaps which separate the South Sandwich Islands from the Clerke Rocks, and the Shag Rocks from the Burdwood Bank. Along the southern arm a much more pronounced ridging has been demonstrated, most marked as far as we are at present aware between the South Orkneys and Clarence Island, where at certain points the sea-floor rises to within 500 m.[3] of the surface. Between the South Orkneys and the South Sandwich Islands there is evidence that the connecting ridge is also a pronounced one, but here, perhaps more than in any other sector of the arc, many more soundings are needed before the exact nature of the connection can be adequately understood. The earliest evidence of any connection is from the soundings taken by the 'Scotia'[4] between 1903 and 1904, when Bruce demonstrated that the coastal shelf of the South Orkneys extended for seventy-five miles east by south of Laurie Island, and farther eastward obtained soundings of slightly over 1000 m. in about 32° W, west by south of Southern Thule in the South Sandwich Islands. More convincing evidence was produced in 1911, when the 'Deutschland' found a substantial rise in 37° W about midway between the shallow soundings of the 'Scotia'. Owing to the northerly out-thrusting of the Weddell Sea ice between the South Orkneys and the South Sandwich group the 'Discovery II' was unable to obtain soundings in this sector of the arc until her return from the Weddell Sea in January 1932, when she found a very pronounced ridge in 36° W and between 60° and 61° S with a minimum sounding of only 543 m. From the above evidence Herdman concluded that there was a strong probability of a connection between the South Orkneys and the South Sandwich group, but expressed the hope that more soundings would be obtained in this area in the near future. Some, although not enough, have been obtained. In late November 1932, while following a somewhat irregular easterly course along the ice-edge between the South Orkneys and Southern Thule, we took many soundings both on and off the ridge until we were finally forced off it into deeper water by a northerly trend of the pack-ice in 32° W. These recent observations, while fully bearing out Herdman's conclusions and emphasizing further the sharply defined character of the submarine connection, suggest the interesting possibility that a gap may occur in it approximately between 33° and 34° W. The existence of this gap was first suggested in 1933 by Wüst,[1] who based his conclusion on the fact that there is cold bottom water in the Scotia Sea which must come from the Weddell Sea. Wüst places his gap approximately between 33° and 35° W, and assigns to it a "saddle depth" of about 2750 m.; but while our soundings favour its existence they are as yet far too few upon which to form any more definite conclusion.

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[1] Suess, E., 1909, *Das Antlitz der Erde*, III, 2, p. 558.

[2] A name proposed by Mr J. M. Wordie and employed by Herdman in 1932.

[3] Herdman, H. F. P., 1932, *loc. cit.*, pp. 227–9.

[4] See Bruce, W. S., 1905, *Bathymetric Survey of the South Atlantic Ocean and Weddell Sea*, Scott. Geog. Mag., XXI, No. VIII, pp. 404–8.

CLIMATE

For the last thirty years or more a continuous meteorological record has been kept on Laurie Island, and the climate of the South Orkneys is thus known with greater precision and in more detail than that of any other part of Antarctica. In the 'Scotia' reports and in the *Annals of the Argentine Meteorological Office*,[2] in the *London Meteorological Magazine*, and in other journals, and in such generalized works on polar problems as Rudmose Brown's *The Polar Regions*, a considerable mass of meteorological literature has accumulated dealing with the South Orkneys. Much of this information, based on the data collected between 1903 and 1925, has been summarized in the first edition of *The Antarctic Pilot*, 1930, pp. 55–6, and 165, and on this and on Mossman's valuable monograph in the 'Scotia' reports,[3] and Rudmose Brown's *The Polar Regions*, the following somewhat condensed account of the climate of the South Orkneys is largely based.

In view of their geographical position, set in the open sea far from any considerable land mass yet intimately associated with a vast reservoir of ice to the southward and not altogether beyond the influence of a warmer westerly drift to the north, the climate of the South Orkneys may vary greatly in character from season to season, and sometimes from year to year. It is essentially a complex one. From about the middle of November—the last spring month—until early April—the middle autumn month—the climate is definitely oceanic, for then the islands are partially or entirely surrounded by open water, and the chilling, potentially continental influence of the Weddell Sea pack-ice as a rule is far removed. For the rest of the year—from late autumn throughout winter to spring—the South Orkneys generally become involved in a sheet of pack-ice of continental magnitude and exhibit the climatic extremes characteristic of a continental station.

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[1] Wüst, G., 1933, *Schichtung und Zirkulation des Atlantischen Ozeans. Das Bodenwasser und die Gliederung der Atlantischen Tiefsee*, Wiss. Ergebn. d. Deutsch. Atlant. Exp. 'Meteor', 1925–7, VI, part 1, pp. 44–5, plate ii (Berlin and Leipzig).

[2] Vols. XVI, XVII, Buenos Aires, 1905, 1912.

[3] Mossman, R. C., 1907, *Meteorology*, Scientific Results of the 'Scotia' 1902–4, II, part 1, pp. 1–306.

In a broad sense, then, it is true that for a period of seven or eight months (from about April to November) the South Orkneys are subject to continental climatic conditions, while it is only for four or five months of the year (from about November to March) that they possess a climate typical of their oceanic situation. The matter cannot however be stated so simply as this, largely owing to the uncertainty both as to time and place of the major movements of the pack-ice in the neighbourhood of the group. In the first place, the period during which the islands remain firmly enveloped in the frozen sea does not fall within definite time limits, with the result that the continental character of the climate is sometimes emphasized at the expense of the oceanic, and vice versa. For instance in 1908, according to Mossman, the South Orkneys were surrounded by open sea practically throughout the year. No pack-ice was seen in their neighbourhood, and indeed no sea-ice of any description except during fifty-two days in July and August, when a level plain of young ice formed over the sea as the temperature fell. As a result of this abnormally open year temperatures were generally high, the climate being largely oceanic for the greater part of the year. Secondly, the degree of the envelopment itself may vary considerably, or in other words the northern edge of the frozen sea, instead of lying as it sometimes does a hundred or more miles north of the islands, may on occasion lie much farther to the south in close proximity to the islands themselves. When the winter ice-edge lies thus far to the south a further climatic complication is introduced, for in the region where a frozen meets an unfrozen sea a "theatre of cyclonic activity" is created where great variations of temperature and weather prevail according as depressions pass to the north or south of the observer. It is "an area of much cloud, strong winds, and considerable precipitation". Unsteady winter conditions such as these, although on the whole uncommon, were experienced by Mossman during the first of the two winters, 1903 and 1904, which he spent at Scotia Bay. They afford a striking contrast to the far steadier conditions which prevailed during the second winter when the islands were well and truly enveloped in a frozen sea. "In 1903" he writes "there was open sea in close proximity to these islands, and the resulting weather was tempestuous, relatively mild, cloudy and variable to a degree; but in 1904 the pack extended some 200 miles to the north, and the weather was quite cold and in general clear, with a high barometer."

In spite of their oceanic position and comparatively low latitude the climate of the South Orkneys is cold. They are situated in the path of one of the major Antarctic current systems, the Weddell Sea drift, which passing clockwise round the Weddell Sea approaches the group from the south-west, carrying with it ice-cold water, sometimes pack-ice, and generally large numbers of bergs. With this cold stream constantly flowing past the group the temperature even in summer seldom rises more than 5 or 10° F. above freezing. The mean annual temperature is 24° F., mean summer 32° F., and mean winter slightly over 14° F. The average temperature of February, the warmest month, is 33° F., and that of July, the coldest, 13° F. The highest recorded temperature for summer up to the year 1925 is 52° F., and the lowest for winter −40° F., but both these extremes are highly exceptional and even an approach to them is rare. In summer, however, the temperature frequently rises to about 40° F., and winter temperatures of −20° F. are not uncommon. While Föhn winds are blowing the temperature, even in winter, may rise above 40° F.

A comparison of these figures with those obtained by Charcot[1] at Port Circoncision on the west Graham Land coast shows what a marked effect the Weddell current has on the climate of the South Orkneys. Port Circoncision, though situated in 65° 10′ S, 64° 14′ W, more than 250 miles south of the latitude of the Laurie Island station, would nevertheless seem to have a climate which is actually milder than that of the South Orkneys. Charcot's observations from January to November 1909 point to a mean annual temperature of about 26° F., a mean summer one of about 34° F., and a mean winter of 20° F. The lowest winter temperature he records is only −11° F.

The prevailing winds are westerly and south-westerly, 57 per cent of all observations being from those directions. North-westerly and south-easterly winds are also fairly common, the former prevailing in the northern semicircle; but winds from the north, north-east, east and south are relatively infrequent. The warmest come from the north and north-west, the coldest from the south. The winds blow strongly throughout the year, frequently reaching gale force, especially in March and April and in August and September. The calmest months are December, January and June, but all three can be boisterous on occasion. The mean annual barometric pressure is 993 mb. It varies only slightly from month to month but is highest as a rule in winter. The mean annual cloudiness (scale 0–10) is 8·5, the South Orkneys being situated in one of the cloudiest regions in the world. The sky as a rule is most heavily overcast throughout the late spring, summer, and early autumn months, that is from November to March. The late autumn and winter skies are the clearest. The relative humidity is extremely high, nearly 90 per cent. Precipitation is heavy and is chiefly in the form of snow, although rain is not unusual in summer. Throughout the year fog or mist is exceptionally prevalent owing to the meeting of the warm north-westerly and northerly winds with the cold air over the glaciated land or the ice-covered water in its vicinity.

The observations of the meteorologists on Laurie Island are said to be of the highest value to the Argentine Republic, inasmuch as it has been claimed that the temperature conditions at the South Orkneys in any winter are an index of the rainfall in various parts of Argentina some time later. Fifteen years after the inception of the observations Mossman wrote:

> Generally, the statistical analysis indicates that a very cold winter at the S. Orkneys will be followed after an interval of 3½ years by a drought over the great cereal belt of Argentina, a very mild winter by bountiful rains. This remarkable relationship has held good for the past few years, and though the physical mechanism involved is obscure, it is certain that the varying temperature of

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[1] See *Antarctic Pilot*, p. 167.

the S. Atlantic caused by the fluctuating quantity of polar ice induces changes in the volume, direction, and temperature of the great ocean currents, which will in turn affect the pressure of the overlying air and lead to changes in the tracks of the cyclonic and anticyclonic systems which dominate climatic conditions in Southern America.[1]

PACK-ICE[2]

For a longer or shorter period every year, beginning as a rule before and extending through and beyond the winter months, the South Orkneys are surrounded by pack-ice.[3] Even the comparatively short open season, however, is sometimes interrupted by the arrival of a broad stream of ice which may partially or wholly envelop the group. Such streams as a rule are formed of loosely knit floes and their existence in the neighbourhood of the islands is fleeting, although they have been known during the whaling days to block the entrance to one of the harbours for as long as six days on end, even in the height of summer, to the great inconvenience of the whale-catchers and floating factories using it as a base. But the pack which approaches and eventually envelops the South Orkneys in a more or less solid sheet throughout the winter arrives with southerly winds. Drifting into the bays and straits as the temperature falls, the floes gradually become cemented together by younger ice or jammed tightly against each other by their own momentum, until with the advance of winter the group is completely invested by a more or less compact and occasionally immovable ice-sheet.

The main drift of the water in the neighbourhood of the South Orkneys is easterly, and pack-ice, and especially icebergs, are known to be carried past the group in that direction. Current, however, is a less important agent in the transport of pack than wind, and it is in fact, as already noted, southerly winds that are responsible in the main for driving the ice on to the southern coasts of the islands. Mossman describes how after a hard south-easterly gale accompanied by a moderate sea—a sure sign of heavy obstruction to the southward—pack-ice appeared in the south-east on April 30, 1904, and, approaching rapidly, entered Scotia Bay on the same day. Thus with south-easterly gales the eastern part of the South Orkneys, especially the south side of Laurie Island, together with Washington and Lewthwaite Straits, is liable to become blocked at an earlier date than the region to the westward. Within recent years the 'Discovery' and 'Discovery II', in the course of their several visits to these islands in late summer or autumn, have been able to reach and obtain shelter on the east coast of Signy Island or in Sandefjord Bay without any great difficulty, while farther to the eastward the south coasts were unapproachable owing to the pack-ice which blocked them.

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[1] Mossman, R. C., 1918, *The Climate and Meteorology of the Antarctic and Sub-Antarctic Regions*, Journ. Scott. Met. Soc., XVIII, No. XXXV, p. 29.

[2] Except where otherwise stated this account is largely indebted to the observations of Rudmose Brown, Mossman, and Pirie in *The Voyage of the 'Scotia'*, and to the ice summary in the first edition of *The Antarctic Pilot*, p. 56; see also Annals of the Argentine Meteorological Office, vols. XVI, pp. 176–88, 1905 (Buenos Aires), and XVII, part 2, pp. 163–9, 1912 (Buenos Aires).

[3] A notable exception was the year 1908, which was abnormally open: the winter pack-ice never reached the group and in its absence the bays froze over, a thin and level sheet of ice forming as the temperature fell. This ice lasted only for 52 days during July and August (see also pp. 338–9).

The distance to which the pack may extend beyond the group to the north varies greatly from year to year. In the summer of 1904–5, on December 30, the 'Uruguay' met loose and evidently northwardly dispersing pack in 58° 40′ S, 50° 30′ W, while she was still some 240 miles north-west of the islands, and on this somewhat indirect evidence Mossman assumes that during the winter of 1904, which was a particularly hard one at the South Orkneys, the northern edge of the pack-ice lay some 200 miles to the north of the group. While there is no direct evidence either for or against this assumption there can be little doubt that the ice-edge in 1904 lay very much farther north than it did the previous winter, when from all accounts there appears to have been open sea within ten miles of Saddle Island throughout the period during which the group was beset.

In severe winters such as that of 1904, the floes on the whole tend to be firmly packed in the immediate vicinity of the group (see p. 338), but in mild winters such as that of 1903, when there is open sea within a few miles of the northern coasts, there is usually much movement among the floes, and pools of open water may appear from time to time in the neighbourhood of the islands for as long as they remain in the grip of the ice. Indeed, during the winter of 1903 the only part of the enveloping ice-sheet which did not break up at one time or another was the fast ice covering the small anchorage at the head of Scotia Bay. Owing to the general northerly movement of the ice the floes tend to become more firmly packed against the southern than against the northern coasts, and in consequence, whether the winter be mild or otherwise, the northern as opposed to the southern floes are always relatively unstable. The difference is most marked, however, in mild winters, owing to the prevalence of north-westerly winds whose resulting swells have little difficulty in penetrating the narrow band of pack by which the northern coasts are beset. J. H. Harvey Pirie in *The Voyage of the 'Scotia'* states that during the winter of 1903 in Jessie Bay on the north coast of Laurie Island the "land-floe" never held more than about two miles from the Beach. "As late as July 17th", he remarks, "after a north-west wind and swell which broke up the ice, a south-west wind carried out the pack, and there was nothing but open water in sight; then the pack-ice would drift back, become frozen together, but sooner or later undergo again the same breaking-up and drifting-out process."[1] On the south coast, on the other hand, he states that the greater part of Scotia Bay was immovably packed throughout the winter, the firm ice sometimes holding as far out as Ailsa Craig at the mouth of the bay and round Cape Burn Murdoch. Outside of Ailsa Craig, however, there was almost always a strip of open water, beyond which the steady easterly drift of the bergs and pack-ice could be observed from the anchorage where the 'Scotia' lay.

In any normal winter pressure ridges may occur in the pack-ice,[2] to the south of the group in particular, wherever the progress of the advancing ice is stemmed by outlying rocks such as Ailsa Craig. These rocks tend to become foci of pressure, and against their steep sides the ice piles up in ridges as much as twenty feet in height.

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[1] According to Argentine observations Uruguay Cove at the head of Jessie Bay rarely if ever remains firmly frozen for more than a week or two at a time, and then only during exceptional seasons when the ice belt extends for a long way to the north of the group.

[2] See Pirie, J. H. Harvey, 1913, *Glaciology of the South Orkneys*, Trans. Roy. Soc. Edin., XLIX, part IV, p. 861.

Before the floes become firmly frozen for the winter there is a period of intensive ice action,[1] when the still unconsolidated pack, drifting to and fro on the tide or hurled hither and thither by wind and wave, grinds and polishes the rocks and boulders of the shore, as well as any off-lying rocks it may contrive to override in its path (Plate XII, fig. 3). The movement of the ice has been stated to produce occasional scoring or striae in the rocks, resulting from the action of the stones which are sometimes frozen or embedded in the under sides of the floes. With the gradual consolidation of the pack the grinding action of the floes is reduced to a minimum. None at all can take place in the depth of a hard winter, when as a rule the pack lies hard and immovable against the land and is consequently inactive. Yet in certain years, as in the mild winter of 1903, when it never really becomes consolidated and there is at all times considerable movement among the floes, there can be little doubt that much ice action must take place all round the coasts throughout the period of their envelopment, even during the coldest months.

Widespread disruption of the ice, the prelude to its final departure for the summer, is caused by ocean swells, especially by those from the north-west. As we have already seen, however, in mild winters when the pack-ice does not extend very far to the north of the group and there is open water close at hand, circumscribed areas of the enveloping ice-sheet may break up sporadically all round the coasts for as long as they remain beset. Northerly and westerly swells also play a part in the dislocation of the floes, but the effect of swells from the eastward or north-eastward must be negligible, or at any rate very slight, owing to the almost complete absence of winds from that direction. Thus while the break up of the ice to the northward may be ascribed to north-westerly or northerly swells, disruption on the south or leeward side of the group may generally be taken as a sign that the seas are clear of obstruction to the westward. Winds from a southerly quarter tend to drive the disrupting ice northwards away from the group. Throughout the month of December in particular there is a marked tendency to south-westerly winds and these must help largely to carry the already loosened ice northwards to scatter and melt.

If we disregard such exceptional years as 1908, when no winter pack-ice came at all, and the occasional advent of broad streams of ice in summer, it would appear from the available records that pack as a rule may be expected to arrive and subsequently surround the group any time between the beginning of March and the end of May, and commence to break up and disperse any time between the beginning of November and the end of January. In 1910, however, Scotia Bay did not become blocked until July 25, while the winter of 1904 dragged on until the following summer was well advanced before the ice covering the bay finally broke up and dispersed, the actual date of opening being February 6, 1905. According to Mossman an even later date may be assigned to the opening of Scotia Bay following the winter of 1902; for when the 'Scotia' first came to the South Orkneys in early February 1903 the whole of the south coast of Laurie Island seems to have been blocked by pack-ice, and from the appearance of the ice-foot in Scotia Bay when she at length anchored there on March 25, there was a strong suggestion that the ice had but recently broken away.

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[1] See Pirie, J. H. Harvey, 1913, *loc. cit.*, p. 861.

Mossman, basing his information on the data for 1903–14, states that Scotia Bay is closed with compact ice for an average of 177 days in the year, the periods varying from 272 days in 1904 (actually 1904–5, since the bay did not open until February 6, 1905), to only 52 days in 1908. In 1911, 1918 and 1919, according to Rudmose Brown,[1] the bay was blocked for periods of less than three months, in 1920 for as long as eight and a half.

Although the opening and closing of Scotia Bay has now been observed for more than thirty years, the period during which a single bay is blocked should not be accepted unreservedly as an index of the ice conditions for the group as a whole. The envelopment of the group, far from being instantaneous, tends to take place gradually, the eastern portion as we have seen sometimes being liable to earlier blockage than the western, with the result that any one bay, particularly on the south coast, may become blocked, while the rest of the group, for the time being at any rate, is comparatively ice-free, and vice versa. On April 2, 1934, the 'Discovery II' found both Washington and Lewthwaite Straits rather heavily packed up, the ice apparently being up to Laurie Island and blocking Scotia Bay, but Signy Island and the whole of the south and west coasts of Coronation Island, and probably the north coast as well, were surrounded by open water. Other instances might be mentioned. Thus the congestion of any particular bay or strait need not necessarily be an indication that the group as a whole is similarly congested, although it does mean no doubt that sooner or later it will be. And so too with the dispersal of the pack. In the comparative shelter and constricted space of the bays and straits the ice tends to cling a little longer, especially on the southern side of the islands, while elsewhere the main body of the enveloping pack is dispersing and much of the group is comparatively ice-free. Following the severe winter of 1904 the 'Uruguay', after a quick passage through the ice, reached the South Orkneys on December 31, and finding open water on the northern side of the group was able to drop anchor in Uruguay Cove. When she sailed again the following day Scotia Bay was still frozen over with fully two miles of firm ice intervening between a strip of open water to the southward and the head of the bay. It was actually over a month later before this ice-sheet finally broke up.

A valuable summary of the ice conditions in the neighbourhood of Laurie Island, as they appear from Scotia Bay, is given in the *Annals of the Argentine Meteorological Office*, vol. XVII, part 2, pp. 163–9. It is based on continuous daily observations (on icebergs as well as pack-ice) for the period 1903–10. The ice records presented here date from the first sighting of the group down to the present day. They are concerned only with pack-ice and in the majority of instances[2] only with that somewhat indefinite period, the "open" season, during which the South Orkneys as a rule are accessible to shipping. For the most part they are records obtained from vessels which have visited or sighted the group, or have passed to the north or south of it without actually sighting the land. They are largely therefore the records of those who have viewed the islands as a whole, and not from the somewhat restricted outlook of Scotia Bay. Although far from complete they show among other things when vessels have reached or have failed to reach, or have set sail from the South Orkneys. Except where otherwise stated the records have been gathered from the following sources: (1) those already cited in the historical section of this paper; (2) the *Annals of the Argentine Meteorological Office*, vol. XVII, part 1, pp. 3–7; (3) *The Voyage of the 'Scotia'*; (4) various official reports in the Colonial Office from whaling officers at the South Orkneys; (5) *Reports of Proceedings* to the Discovery Committee from Masters of the research vessels 'Discovery' and 'Discovery II'.

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[1] Brown, R. N. Rudmose, 1923, *A Naturalist at the Poles*, p. 153 (London).

[2] In a few instances winter seasons have been considered, notably those that were exceptionally mild or severe.

SEASON 1821–2

'Dove', George Powell, December 5–13, 1821. For all practical purposes the group was entirely free of pack-ice. On December 13 the northern edge of heavy pack lay about 100 miles due south of the islands in 62° 20′ S, 45° 29′ W. Powell reports "a great quantity of ice" about thirty miles north-west of the Inaccessibles, and "a vast quantity of ice that was drifting about in every direction" off the south-west corner of Coronation Island. In neither instance, however, does he state whether it was pack-ice or icebergs that he meant, but in both he probably referred to streams of pack detached from the main body in the south (see p. 295 and Fig. 1).

'Beaufoy', Michael Macleod, December 10–13, 1821. The sea for about 200 miles south-west of the islands evidently free of close pack, and probably quite or at any rate fairly open as far south at least as 62° 30′ S, in 52° 30′ W. Compare Powell's practically simultaneous observation as to the position of the ice-edge to the eastward. Although our only authority for this statement is Weddell's track chart it is nevertheless obvious that a vessel of the size of the 'Beaufoy' (about sixty-five tons) could not have sailed where she did had the sea been obstructed by close pack (see p. 307, Fig. 3).

'Jane', James Weddell, February 9–10, 1822. The northern side of the group at least was probably clear of pack (see p. 309 and Fig. 3).

SEASON 1822–3

'Jane' and 'Beaufoy', James Weddell and Matthew Brisbane, January 12–23, 1823. The group was entirely free of pack-ice. After leaving the South Orkneys, Weddell, standing southwards through open water, eventually reached 74° 15′ S, in 34° 16′ 45″ W, where on February 20 there was a clear sea to the south.

'Wasp', Benjamin Morrell, March 14, 1823. On this date Morrell states that he reached 70° 14′ S, in 40° 3′ W, the sea to the southward being clear of all obstruction.[1] This record, if reliable (which is extremely doubtful), would indicate a prolongation to a rather late date of the phenomenally open condition of the Weddell Sea observed by Weddell in January and February.

SEASON 1837–8

'Astrolabe' and 'Zélée', Dumont D'Urville, January 26–29 *and February* 20–22, 1838. On both occasions the group appears to have been clear of pack-ice. There was pack about twenty miles away to the south of Laurie Island on January 26, but the main body of the ice lay considerably farther to the south (see p. 313).[2]

SEASON 1842–3

'Erebus' and 'Terror', James Clark Ross, January 17–*February* 14, 1843. The northern edge of heavy pack lay in 64°–65° S between Graham Land and the 40th meridian west longitude, approximately 240 miles due south of the South Orkneys.[3]

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[1] Morrell, B., 1832, *A Narrative of Four Voyages*, pp. 66–7 (New York).

[2] D'Urville's Atlas, 1, Chart 2, 1846 (Paris).

[3] Ross, J. C., 1847, *A Voyage of Discovery and Research in the Southern and Antarctic Regions, during the Years* 1839–43, pp. 350–7 (London).

SEASON 1873–4

'Grönland', Eduard Dallmann, January 25–February 11, 1874. The group apparently quite clear of pack-ice. On January 25 the ice-edge lay approximately 120 miles south of the South Orkneys see p. 317).[1]

SEASON 1892–3

'Jason', C. A. Larsen, November 16–circa 24, 1892. The northern side of the group at least was apparently clear of pack-ice (see p. 318).

SEASON 1893–4

'Jason', C. A. Larsen, November 23, 1893. The ice-edge lay approximately 150 miles to the southward of the group. It was trending rapidly north-eastwards towards the South Orkneys which may well have been blocked.[2]

SEASON 1902–3

'Scotia', W. S. Bruce, February 2–5, 1903. Fairly heavy pack with scattered pools and lanes of open water blocked the north, east, and apparently the south coasts of Laurie Island. Lewthwaite and Washington Straits were blocked. Saddle Island was clear (surrounded by a pool of open water) and a party from the 'Scotia' landed there. On February 2 the 'Scotia' met the ice-edge north-north-east of Laurie Island in 60° 20′ S, 43° 50′ W. At this point it was compact and trending slightly north-eastwards. Between the meridian of Cape Dundas and that of the southern tip of the Sandwich group the ice-edge stretched roughly along the 60th parallel.[3]

'Scotia', W. S. Bruce, March 21–30, 1903. The pack was evidently up to the southern side of the group but not necessarily blocking it entirely. The eastern part of the south coast of Laurie Island was heavily blocked, but to the east, north and south-west that island was clear. The 'Scotia' steamed south through Lewthwaite Strait on March 23 and entered Scotia Bay, which was clear, on March 25. The ice which lay immediately to the southward entered the bay two days later and became consolidated on March 30. Note that a good deal of the pack encountered by the 'Scotia' on February 2 would in the meantime appear to have dispersed, since Laurie Island from March 21 until March 25 seems if anything to have been less heavily beset than it was in early February.

WINTER SEASON 1903

Scottish expedition in winter quarters on Laurie Island, March 30–November 27, 1903. From about the beginning of April until the end of October the group was enveloped in what seems to have been an only partially consolidated and constantly moving mass of pack-ice which probably did not extend more than a few miles north of Saddle Island. Although Scotia Bay did not open until November 23, by the end of October the greater part of the enveloping ice appears to have broken up, especially in the north, and much of it to have dispersed. Uruguay Cove opened as early as July 17, while in the south by October 19 a large part of the ice-sheet was entirely broken up. The 'Scotia' sailed for South America on November 27.

SEASON 1903–4

Scottish and Argentine parties on Laurie Island, November 27, 1903–April 30, 1904. Almost throughout the whole of this period the group appears to have been clear of pack-ice.

'Scotia', W. S. Bruce, February 14–22, 1904. The group was entirely free of pack-ice. On February 27 the 'Scotia' encountered streams of loose pack as she crossed the Antarctic Circle in about 32° W.

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[1] See L. Friederichsen's *Originalkarte des Dirck Gherritz-Archipels*, 1895 (Hamburg).

[2] *Ibid.*

[3] See Bruce, W. S., 1904, *First Antarctic Voyage of the 'Scotia'*, Scott. Geog. Mag., xx, No. II, p. 58.

WINTER SEASON 1904

R. C. Mossman, Director of the first Argentine meteorological staff on Laurie Island, April 30–*December* 30, 1904. From about May 11 until the end of November the South Orkneys were heavily beset, the pack for the greater part of this period being on the whole firm and compact. Mossman believed the ice to extend for about 200 miles to the northward of the group (but see p. 348). The first pack appeared in the south-east on April 30 following a hard south-easterly gale. The same day it entered Scotia Bay, becoming consolidated there on May 11. Uruguay Cove became firmly covered over at the beginning of July, but on October 27 the ice there broke and went out. On November 26 the ice left Wilton Bay. By the end of November much of the ice in the immediate vicinity of the group appears to have become loosened, especially in the north. By the end of December, following a succession of south and south-west winds, there was open water to the north of the islands, with apparently some pack beyond. It is of interest to note that even in the depth of this hard winter the ice in the north appears to have been much less compact than it was in the south, for Mossman states that in July "the ice in Uruguay Cove and a considerable part of Jessie Bay was bearing during most of the month, and swell was rarely observed".

SEASON 1904–5

'Uruguay', I. F. Galindez, December 30, 1904–*January* 1, 1905. On December 30 the 'Uruguay' encountered pack in 58° 40′ S, 50° 30′ W, about 240 miles north-west of the islands. She seems to have had little difficulty in passing through it, for she anchored in Uruguay Cove the following evening. To the north of the group for several miles there was open water with pack beyond. The southern coasts, however, were still fairly heavily beset, Scotia Bay being firmly frozen over for a distance of about two miles from the head of the bay. The 'Uruguay' sailed for the South Shetlands late on January 1 sighting Cape Melville on the forenoon of January 7.

SEASON 1905–6

'Austral', L. Saborido, January 30–*February* 23, 1906. The 'Austral' arrived in the vicinity of the group on January 30, a landing being effected on February 2. She sailed on February 23. During her visit the islands were ice-free.

SEASON 1906–7

'Uruguay', R. J. Hermelo, December 23, 1906–*January* 2, 1907. When the group was sighted on December 23 the whole of the north side of Laurie Island was blocked by pack as far as Saddle Island. In order to reach Scotia Bay the 'Uruguay' was compelled to steam west about round Coronation Island, which seems to have been less heavily beset than Laurie. The ice in Scotia Bay still held, extending fully two miles from the anchorage. On December 31 the bay opened. The 'Uruguay' sailed on January 2.

SEASON 1907–8

'Uruguay', J. Yalour, February 6–13, 1908. The 'Uruguay' arrived in the vicinity of the group on February 6, a landing being effected on February 9. She left on February 13. The islands were ice-free. For the rest of the year 1908, as already noted, remarkably little ice was seen (see p. 347, footnote 3).

SEASON 1908–9

'Uruguay', C. Somoza, February 7–11, 1909. The 'Uruguay' reached the South Orkneys on February 7 and sailed on February 11. No pack-ice was seen. Although the early part of it was not so ice-free the year 1909 on the whole may also be regarded as a fairly open one. On February 28 large quantities of heavy ice, some of it twenty feet in thickness, entered Uruguay Cove. During March and April there was much ice in the neighbourhood of the islands, drifting in and out of the

bays with every change of wind. It was not, however, until May 24 that Scotia Bay finally became frozen and by the early date of November 5 all pack had cleared away from the group.[1]

SEASON 1909–10

'Uruguay', February 1910. The 'Uruguay' arrived early in February the islands being ice-free.[2] During the year 1910 Scotia Bay did not become blocked until the last week in July and broke up again as early as November 18.[3]

SEASON 1910–11

'Uruguay', February 1911. The group was quite clear early in February when the 'Uruguay' arrived. Throughout the summer of 1910–11, however, there had been much pack around the islands and the ice did not disperse until early February, a few days before the relief ship arrived.[3]

WINTER SEASON 1911

The winter was an exceptionally mild one. Scotia Bay did not become blocked until June 28 and broke up on September 23.[4]

SEASON 1911–12

'Falkland', from about the beginning of January until about the end of February 1912. No details as to the presence or absence of pack-ice are given. The 'Falkland' apparently arrived at the group about the middle of January 1912 (see p. 325), but evidently one of her whale-catchers, the 'Powell' (Petter Sörlle), arrived before her, possibly about the beginning of the month. The 'Falkland' lay in Falkland Harbour at the southern end of Powell Island until about the end of February or possibly the beginning of March.

According to Argentine observations[5] pack was seen in the neighbourhood of the islands in January, while the winter ice seems to have arrived about the middle of April.

'Undine', February 1912. At the end of February 1912 the staff of the meteorological station was relieved by the 'Undine'.[6]

SEASON 1912–13

'Falkland', 'Thule', 'Normanna', 'Tioga', November 1912–*March* 1913. From November 20 until the end of December the group was entirely blocked by pack-ice. The 'Normanna' reached the land and anchored on January 1 and the other three vessels apparently reached their respective bases about the same time. From that date until about the middle of March whaling seems to have been carried on around the islands so that they would appear to have been more or less free from pack for a period at least as long as two and a half months. The season, however, was regarded by the whalers as a bad one for ice—possibly because their work was hampered, as sometimes happens, by the periodic encroachment of streams of ice from the southward, or possibly because they were so late in gaining access to the land. Falkland Harbour, Normanna Strait, and the west side of Signy Island were used as bases (see p. 327).

According to observations from Scotia Bay[7] there was ice in the neighbourhood of the islands until the end of January and the winter pack arrived on May 27.

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[1] See Mossman, R. C., 1910, *Meteorology in the Weddell Quadrant during* 1909, Scott. Geog. Mag., XXVI, No. VIII, pp. 408–11.

[2] *Ibid.*, p. 408.

[3] See Scott. Geog. Mag., 1911, XXVII, No. VII, p. 377.

[4] *Ibid.*, 1912, XXVIII, No. V, pp. 268–9.

[5] See Mossman, R. C., 1922, *Las Condiciones Físicas del Atlántico Sur entre el Río de la Plata y las Islas Orcadas del Sur*, República Argentina, Oficina Meteorologica Nacional, pp. 11–12, text-fig. 9.

[6] See Scott. Geog. Mag., 1912, XXVIII, No. V, pp. 268–9.

[7] Mossman, R. C., 1922, *loc. cit., supra*, pp. 11–12.

SEASON 1913–14

'Polynesia', 'Thule', 'Normanna'. No ice details are given other than that there was less pack in the neighbourhood of the islands than in the season before. The season, however, was regarded as an open one. All three vessels lay in Borge Bay on the east coast of Signy Island (see p. 326).

SEASON 1914–15

'Falkland'. Pack-ice in a solid sheet surrounded the group for 100 miles to the north so that the 'Falkland' was unable to reach her anchorage (Borge Bay) until as late as January 19. According to Argentine observations[1] there was ice in the neighbourhood of the group until February 17 and the winter pack arrived on April 20.

THE PERIOD 1915–21

I have been unable to obtain access to ice observations of the vessels that visited the South Orkneys during this period. Details of the ice conditions in the neighbourhood of Laurie Island throughout this period, together with the dates of the opening and closing of Scotia Bay, will be found in Mossman, 1922, *Las Condiciones Físicas del Atlántico Sur, etc.*

SEASON 1921–2

'Quest', Frank Wild, March 14–21, 1922. During this period the 'Quest' was beset in approximately 63° 51′ S, 45° 13′ W, about 180 miles south of the islands.[2]

SEASON 1922–3

'Orwell' (old), December 15, 1922. The season appears to have been an open one. The 'Orwell' reached the land on December 15. It is not stated how long she remained.

SEASON 1923–4

'Orwell' (old), November 7, 1923–*January* 9, 1924. The season was not an open one. On November 7 the 'Orwell' met the ice-edge north of the group in 58° S and was unable to reach the land until January 5. For some time afterwards there was apparently a good deal of pack in the neighbourhood of the islands, the entrance to Borge Bay being blocked from January 5 to 9. No other details are given.

SEASON 1924–5

'Orwell' (old). The season was an open one.

SEASON 1925–6

'Orwell' (new), December 20, 1925–*April* 7, 1926. A long and open season. On December 20 the pack apparently lay just north of the islands. The 'Orwell' reached harbour on December 29 and whaling continued from then until April 7.

SEASON 1926–7

'Orwell' (new) and other factory ships, November 12, 1926–*March* 30, 1927. On November 12, 1926, the 'Orwell' met the pack about sixty miles north-west of the group. Between that date and December 12 she whaled on the ice-edge, gradually coming nearer to the South Orkneys as the pack dispersed. On December 13 she entered Borge Bay. The season was a bad one for ice, the islands never being wholly clear of the pack. On several occasions in February the anchorages on the southern side of the group were completely blocked, the whale-catchers being unable to reach their parent ships for days on end.

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[1] Mossman, R. C., 1922, *loc. cit., supra*, pp. 11–12.

[2] Wild, F., 1923, *Shackleton's last Voyage*, pp. 145–7 (London).

'Foca', latter part of December 1926. On January 1 the 'Foca' arrived at Leith (South Georgia) from the South Orkneys and her captain told Mr L. H. Matthews[1] that in the latter part of December he had to wait several days before he could get in to the South Orkneys as Uruguay Cove was full of heavy pack and Scotia Bay full of rotten "land" ice. (Information from Mr Matthews.)

'Don Ernesto', L. H. Matthews, January 8–9, 1927. Although there were still many old and very heavy floes scattered about, the group as a whole was comparatively clear or at any rate approachable. There was heavy but broken pack in Uruguay Cove and in Scotia Bay, and at the head of the latter the fast land ice still clung. On January 9 Washington Strait was blocked but Lewthwaite was clear. (Information from Mr Matthews.)

R.R.S. 'Discovery', J. R. Stenhouse, February 16–20, 1927. The pack lay close to the southern side of the group. Shortly before February 16 Lewthwaite and Washington Straits, the south coasts of Coronation and Laurie Islands, and the eastern side of Signy Island were completely blocked. By February 17, however, the congestion to the south had apparently eased off considerably, since the 'Discovery' had no difficulty in reaching Borge Bay via the south-west corner of Coronation Island on that date. She sailed in open water westwards for Clarence Island on February 20.

SEASON 1927–8

'Orwell' (new), October 19, 1927–*April* 7, 1928. From October 19 until January 15 there seems to have been much pack to the north of the group. During the first half of January the ice was breaking up rapidly and the South Orkneys were in sight on the 15th. The 'Orwell' reached Signy Island on January 31. Small detached streams of pack remained around the islands during February. The 'Orwell' left the South Orkneys on April 7, as the winter pack was closing in around the group.

SEASON 1928–9

'Orwell' (new). The winter pack appears to have been still north of the South Orkneys at the end of December 1928.

'Norvegia', Nils Larsen, January 18–19, 1929. For about eight miles to the northward the group was beset by compact ice preventing access to the land. The ice-edge trended slightly towards the north-east.[2]

SEASON 1930–1

R.R.S. 'Discovery II', W. M. Carey, December 17, 1930. Pack blocked the northern side of the group, which was apparently inaccessible. In the meridian of the western end of Coronation Island the ice-edge lay in 60° S. From there it trended north-eastwards.

R.R.S. 'Discovery II', W. M. Carey, February 14–18, 1931. On February 14 there was loose pack- and drift-ice up to Signy Island but open water extended off the south-western part of Coronation Island. To the west and north, also, Coronation Island was clear, but loose pack filled Washington and Lewthwaite Straits and for about thirty miles to the north of Laurie Island there was loose but navigable pack trending in a north-easterly direction. By February 18 the ice which was approaching from the south had almost reached Sandefjord Bay where the 'Discovery II' had anchored.

SEASON 1931–2

R.R.S. 'Discovery II', W. M. Carey, December 6–9, 1931. The pack lay to the north of the group, the ice-edge lying approximately along the 60th parallel and bending sharply northwards to about 58° 30′ S in about 42° W. The islands were not accessible.

R.R.S. 'Discovery II', W. M. Carey, January 27, 1932. The northern edge of a large body of heavy compact ice lay in 61° 24·4′ S, 36° 00′ W, about forty miles south of the latitude of the southern tip of Signy Island.

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[1] Formerly on the scientific staff of the Discovery Investigations.

[2] Aagaard, B., 1930, *Fangst og Forskning i Sydishavet*, II, p. 644 (Oslo).

SEASON 1932–3

R.R.S. '*Discovery II*', *W. M. Carey, November* 22–24, 1932. The group was ice-free. On November 24 the ice-edge was met seventy miles due south of Laurie Island. From that point it trended north-eastwards towards the Sandwich group.

R.R.S. '*Discovery II*', *W. M. Carey, January* 2–30, 1933. No pack-ice was seen anywhere near the group throughout this period.

SEASON 1933–4

R.R.S. '*Discovery II*', *A. L. Nelson, April* 1–2, 1934. The pack was evidently up to and blocking the southern side of Laurie Island. Washington and Lewthwaite Straits were blocked by fairly heavy ice. Signy Island, however, and the western part of the group in general was apparently clear. The 'Discovery II' anchored in Borge Bay and later in Sandefjord Bay (see p. 350).

SEASON 1934–5

R.R.S. '*Discovery II*', *A. L. Nelson, September* 28–30, 1934. The pack lay well to the north of the islands which were inaccessible. Its northern edge, which was loose and inclined to be irregularly produced in streams, was met in 60° S, in about 51° W. From there it trended north-eastwards.

ICEBERGS[1]

In January 1933 a great fleet of icebergs, probably well over 2000 in number, was gathered in the neighbourhood of the South Orkneys, the bulk of them in the comparatively shallow water on the southern side of the group. There, within twenty miles of the shore, at least 1500 were present in the early part of the month; the majority, of which a large proportion were evidently aground, within a few miles of the land, the rest afloat in the deeper water farther out to sea. From east to west they stretched along the entire length of the southern coasts covering the sea for many square miles and occasionally crowded so thickly that in certain circumscribed areas the southern horizon was cut out altogether (Plate XIV, fig. 3). They were heavily concentrated about the southern approaches to Washington and Lewthwaite Straits, no less than 490 being counted there from the southern peak of Powell Island (Plate XIV, fig. 2), while off the south-western corner of Coronation Island, immediately south of Sandefjord Bay, an almost equally heavy concentration had occurred (Plate XIII, fig. 1). To the east of Cape Dundas many more were seen but the number there was not ascertained. Off the northern coasts on the other hand far fewer were met, about 150 in all, and in the straits between Laurie and Coronation Islands icebergs on the whole were comparatively rare, although a few, from thirty to sixty, could generally be seen there either stranded or drifting slowly through on the tide. With few exceptions the latter were inclined to be small, the larger evidently being prevented by their draught from passing far into the straits. By the end of January the total number of bergs in the vicinity of the islands had greatly diminished; many that had been aground had broken up completely, many that had chanced to remain afloat had passed on to the north-eastward with the Weddell drift, which evidently brings these great fleets of bergs down on to the group.

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[1] Notes on the icebergs at the South Orkneys in January 1933 were kept by the Second Officer, Lieutenant R. A. B. Ardley, and to these I am much indebted.

In shape and dimensions the individuals of this great congregation showed considerable variation. Although all were of barrier origin and the larger of them retained their typical barrier form, a great many, perhaps the majority, were relatively small and irregularly angular, and were evidently the result of the breaking down of larger slabs of barrier ice such as appear in the background of Plate XIII, fig. 2. There were others that to all appearances had been stranded for a long time, upon which the sea had wrought to such purpose that they had become polished and rounded and had lost all semblance of their original tabular form. In size and height none was remarkable. In length they ranged from about 300 feet or less to 1½ miles, the smaller predominating, and while the average height above water of the large regular slabs was perhaps 80 or 100 feet, that of most of the smaller and more irregular pieces was very much less. The highest measured was 285 feet, but this was an exceptional one that had broken down and become abnormally buoyant.

No exceptionally unusual forms were noted, though D'Urville, who also encountered enormous numbers of icebergs at the South Orkneys in January and February 1838, records some that were "vraiment merveilleux par leur forme et leur étendue". He describes in particular one that resembled "un immense clocher de 76 mètres de hauteur" and another "une vaste citadelle arrondie", which on closer inspection, was seen to have its interior hollowed out like an amphitheatre recalling that of the Colosseum at Rome.[1] Apart from those that were worn and polished by the sea there was only one berg that particularly claimed our attention, a tabular one with a large circular hole clean through it some distance above the water-line. No doubt there were others of equally arresting form, but irregular bergs of every shape and size were so numerous during our visit that we were inclined to pay less attention to them than we might otherwise have done.

Within a mile or two of the southern shores the majority appeared to be aground. From the John Peaks at the southern end of Powell Island we marked how the smaller had stranded themselves close inshore, the larger farther out to sea. In the great concourse that was stranded about the southern entrance to Washington Strait (Plate XIII, fig. 2) a well-marked increase in size to seaward may be noted. Although the majority of the inshore bergs were thus aground, a few that were apparently of considerable draught were nevertheless observed to be afloat where to all appearances the water was too shallow to accommodate them without their coming in contact with the bottom. On January 12, the 'Discovery II' being at anchor in Ellefsen Harbour, several bergs from 80 to 150 feet in height were observed to be moving slowly northward through Lewthwaite Strait at a point where it is only from 50 to 70 fathoms in depth. A similar phenomenon was observed off the south coast of Coronation Island, where large bergs 150 feet in height were definitely seen to be afloat in from 70–80 fathoms. In view of this evidence it would appear that the bergs in question were of an abnormally shallow draught, and that certain Antarctic bergs of barrier origin must float with no more and sometimes even less than three-quarters of their bulk submerged.

[1] D'Urville, D., 1842, *loc. cit.*, pp. 65–6.

In support of this it may be remarked that the upper strata of a tabular berg are evidently very much less dense than those of its base and under-water portions; for the layers of deposited snow, as a rule evenly laid and relatively broad at the top, narrow successively down to the water-line, where they are often compressed to a small fraction of the width of the upper layers and sometimes contorted by strains.

The presence of many icebergs in the neighbourhood of the South Orkneys is by no means uncommon. From the earliest times nearly every navigator who has visited the group has reported exceptionally large numbers in its vicinity. Nevertheless the number in January 1933 would seem from all accounts to have been an unusually large one.

It is almost certain that the majority of the bergs which reach the South Orkneys in such profusion have their origin in extensive ice-barriers in the south and west of the Weddell Sea. Bergs shed from these barriers pass directly into the north and north-east bound Weddell Current and so are eventually carried to the South Orkneys to strand themselves in the shallow water to the south of the group. Between 1927 and 1933 enormous tabular bergs, one "as large as South Georgia", were reported in the neighbourhood of Clarence Island and in the eastern part of the Scotia Sea. In discussing the origin of these veritable "ice-islands" Wordie and Kemp[1] state that it seems necessary "to assume that there has been in recent years an unusual break up of barrier ice in the Weddell Sea", and they conclude that the disruption has taken place in the unknown south-west portion of the Weddell Sea, between the Filchner Barrier and North Graham Land. The presence at the South Orkneys of phenomenal numbers of bergs in January 1933 may well be associated with the same cause. The break up of a fifty-mile berg stranded in the shoal water to the north-east of Joinville Island, or on the South Orkneys-Clarence Island ridge, might easily result in the sudden appearance of enormous numbers of relatively small, irregular bergs such as we saw. Another possible source of those that congregate at the South Orkneys would be to the east of Coats Land; the resulting bergs would thus go right round the Weddell Sea.

The capacity of the South Orkneys themselves to produce icebergs is extremely small. According to Pirie[2] the forward motion of the glaciers, of Laurie Island at least, is very slight, with the result that they calve infrequently, and when they do, shed only pieces of trifling size and certainly nothing larger than an "ordinary tramcar".

GLACIATION

LAURIE ISLAND. In 1903–4 the glaciers of Laurie Island were studied by Pirie who published a careful and detailed description of them some years after the return of the 'Scotia' from the Antarctic. In that work[3] he observes that the subsidiary rock ridges which branch off the central backbone into the narrow lateral peninsulas of Laurie

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[1] Wordie, J. M., and Kemp, S., 1933, *Observations on certain Antarctic Icebergs*, Geog. Journ., LXXXI, part 5, pp. 431–4.

[2] Pirie, J. H. Harvey, 1913, *Glaciology of the South Orkneys*, Trans. Roy. Soc. Edin., XLIX, part IV, p. 849.

[3] *Ibid.*, pp. 837, 838, 839, text-figs. 1–4, plates i, iii, xi.

Island (Fig. 8) produce a number of entirely cut-off or partially detached ice-formations whose terminal cliffs occupy the heads of the deep transverse embayments which are a feature of the coast. There is a secondary system of similar ice-formations in the peninsulas themselves, since the subsidiary ridges which occupy them have in turn short lateral spurs ending in most instances on the coast in steep or wholly precipitous cliffs. With slight individual variations the majority of these ice-formations correspond broadly with the type described by Nordenskjöld as the "ice-foot" glacier, some details of whose structure, already referred to in a somewhat general way on pp. 336–7, and effect on the underlying land, are given below (pp. 364–6). Excellent examples of this type are to be seen on the north-eastern side of Scotia Bay and in Brown Bay. Towards the eastern end of the island, where the central ridge dies down, the whole of the area from Brown Bay to the base of Ferrier Peninsula is covered by a continuous ice-sheet, which being thin and failing completely to mask the outline of the underlying hills, clearly belongs to the Spitzbergen or as it is now called "highland" type of glaciation. Through low saddles or cols in the central dividing ridge, such as that between Brown Bay and Mill Cove, the glaciers on opposite sides of the island may coalesce to form an ice-sheet continuous from coast to coast. Similar ice-sheets may also occur cutting across the subsidiary ridges of the lateral peninsulas. Where there is such fusion of opposing glaciers there is a combination of the two major forms of glaciation which occur on the island, the "ice-foot" glaciers passing imperceptibly into ice-covers of the highland type.

CORONATION ISLAND. The distinctive feature of the glaciation of Coronation Island, although in many respects it resembles that of Laurie Island, is the relatively great development of highland ice. Pirie is unable to say much of the conditions here because, except for a single landing of short duration in Lewthwaite Strait, Coronation Island was only seen from a distance. He remarks that the land area is wider and higher than that of Laurie Island and is more extensively covered by ice, apparently of the Spitzbergen (highland) variety. On the eastern coast, where he landed, the ice conditions appeared to resemble closely those that were subsequently found on Laurie Island.[1]

Actually the glaciation of Coronation Island is very much as Pirie imagined. Along the whole of the eastern side in particular, where there are a number of ridges running more or less transverse to the coast, the ice-formations like many on Laurie Island are partially detached, and broadly speaking belong to the ice-foot type (Plates XIX, XXI). In general appearance, in its glaciation as well as in other respects, this coast bears a striking resemblance to the north-eastern side of Scotia Bay, the western side of Pirie Peninsula (Plate XXIII, fig. 2) and to other parts of the coast of Laurie Island. There is a marked tendency on this side of Coronation Island for neighbouring glaciers to coalesce laterally at their seaboard ends, a fact which leads one to suspect that the dividing ridges here have undergone and even now are undergoing considerable erosion and change (see pp. 365–6).

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[1] Pirie, J. H. Harvey, 1913, *loc. cit.*, pp. 861–2.

Along the south coast of Coronation Island, from Signy Island to South Cape, there are several ice-foot glaciers and there are others on the west coast (Plate XV, figs. 1, 2, Plate XVII, fig. 2), but elsewhere the glaciation of the island as a whole is very largely highland in character. The highland ice attains its maximum development towards the western end of Coronation Island where the high central ridge falls rapidly away and the whole of the land from coast to coast is covered by a thin and practically continuous ice-sheet. In the region of the narrow neck occupied by Deacon Hill in particular, the land is completely glaciated. Here the highland ice, unbroken and remarkably smooth, reaches the coast both north and south of the neck in long low cliffs which extend along the head of Norway Bight in the south for 2¾ miles—the longest unbroken stretch of ice-cliff in the South Orkneys (Plate XVII, fig. 1). Over the steep western coast this ice-sheet spills in a series of hanging glaciers and confused and heavily crevassed ice-falls (Plate XVII, figs. 2, 3, 4). To the latter John[1] refers in the following passage: "The enormous unbridged crevasses, as much as 30 feet across, forced us to make our way through the chaos of the ice-fall on the right below where the thick ice-field spills over a vertical rock wall. The upper part of the fall consists of pieces of ice some as big as churches, others the size of cottages, lying at all sorts of angles to one another." In the north-western part of the island, as far as we were able to ascertain, the highland ice extends from the neighbourhood of Penguin Point for at least half-way towards Cape Bennett. Along this stretch of the coast the land is comparatively low-lying and rather even in outline, with a gentle slope to the interior. It is, as D'Urville[2] remarked in 1838, almost completely if lightly glaciated, scarcely any bare rock being exposed except for patches here and there near sea level (Plate XVIII, fig. 1). Farther east the north coast was not examined closely. From all accounts the land there is also largely ice-clad, apparently by highland ice. In the eastern half of Coronation Island, where the land mass attains a much higher general level, the highland ice-cap is inclined to be developed in patches, especially over the mountainous region behind the eastern sea-board where some peaks are almost completely covered, others only partially or not at all. At several points on the east coast, as in Laurie Island, the highland ice passes directly into the fringing ice-foot glaciers of Lewthwaite Strait. Along the crest of the central ridge, apparently where it attains its maximum elevation, there is a conspicuous development of highland ice. On the most precipitous of the southern slopes it clings as a thin armouring but occasionally gives rise to ice-falls of considerable magnitude or spills over in hanging glaciers resting somewhat insecurely on the steep rock faces high up beneath the crest (Plate XV, figs. 1, 2).

On the steep mountain sides and buttresses of the southern and eastern coasts small cliff glaciers are not uncommon. Some reach the sea, others, like slabs "plastered against the cliff",[3] hang precariously on the rock face, often at a great height (Plate XV, fig. 1, and Plate XX, fig. 1).

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[1] John, D. Dilwyn, 1934, *The Second Antarctic Commission of the R.R.S. 'Discovery II'*, Geog. Journ., LXXXIII, part 5, p. 393.

[2] D'Urville, D., 1842, *loc. cit.*, p. 74.

[3] Pirie, J. H. Harvey, 1913, *loc. cit.*, p. 858.

In Petters Bay on the east coast there is an ice-foot glacier which is continuous behind with two tongues of ice. The northerly of these presents all the appearances of a true valley glacier and is perhaps the only example of its kind in the South Orkneys (Plate XIX, fig. 4). It is possible, however, that there is another on the eastern part of the north coast (Plate XVIII, fig. 3).

SIGNY ISLAND. In spite of its southerly situation Signy Island is but little glaciated. The land throughout is uniformly low, never rising above 790 feet. It supports merely a light snow and ice field which extends over the greater part of the southern half of the island in a smooth and rather flat sheet, but is not continuous in the north where the land is more irregular and broken (Plate XXII, fig. 1). From the frequency of the rock patches which appear through it, it is evidently nowhere of any great thickness. It has its major outlet in a steeply falling glacier whose foot rests several hundred yards inland at the head of the short valley which opens on to Borge Bay from the south. The foot of this glacier has receded, its original path to the sea being clearly marked by moraines. A small stream flows from it into Borge Bay.

With the exception of a few gentle snow slopes coming from the field above the coasts of Signy Island are remarkably free from glaciation of any form.

In view of the marked development of highland ice over the north-western end of Coronation Island, the most northerly region in the group, it is rather remarkable that Signy Island in the extreme south is not similarly ice-clad. Admittedly the island as a whole is low-lying (a cogent factor as far as ice formation is concerned in such a comparatively low latitude as that occupied by the South Orkneys) and has considerable areas of fairly level ground from which any accumulation of snow might readily be swept away or melted through exposure to high winds or the sun; yet if these be the factors responsible for the discontinuity and lightness of its ice-cap it is difficult to understand why the same factors should not be at work at (say) the western end of Coronation Island in the neighbourhood of Deacon Hill, where the land is not only little if at all higher and almost as level, but exposed to equally powerful winds. Like Signy Island this region is swept by the prevailing westerly and south-westerly winds, and receives the first impact of the warm north-westerlies, the strongest and most frequent of the northerly winds. The latter, far from preventing the accumulation of snow and ice, actually seem to favour it. In fact there can be little doubt that the more or less continuous ice-sheet that exists over the western end and along much of the north coast of Coronation Island is due in a large measure to the dense fogs and heavy precipitation resulting from the influx of warm moisture-laden air[1] over the cold land. It is indeed probable that a great deal of the ice which accumulates over this region is actually deposited out of the mist at low temperatures in the form of rime—not only on the heights but on the low ground bordering the coast as well. The formation of rime at high and low levels is known to occur at the South Orkneys. John[2] records that on the peaks at the south-western corner of Coronation Island "great irregular masses of ice of a porous structure stood out to windward" while the rapid deposition of rime at sea-level out of thick fog was observed by Mossman[1] at Scotia Bay during the winter of 1904.

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[1] See Mossman, R. C., 1905, *Some Meteorological Results of the Scottish National Antarctic Expedition*, Scott. Geog. Mag., XXII, No. v, p. 257.

[2] John, D. Dilwyn, 1934, *loc. cit.*, p. 393.

From the influence of these warm damp winds Signy Island is largely protected by the higher mass of Coronation Island, and it is to this more than anything else that its comparatively ice-free condition is probably due. No doubt there are other factors involved, such as the general low level of the island, but that at any rate cannot be the deciding factor in view of the marked glaciation at equally low levels of more northerly parts of the group.

POWELL ISLAND. Powell Island is narrow, high and steep. It is covered largely by highland ice, which is light in the extreme south (Plate XXII, fig. 2) but considerably heavier at the northern end of the island where it gives rise to suspended cliff glaciers (Plate XXII, fig. 3).

OTHER ISLANDS. With the exception of Christoffersen, Saddle and Larsen Islands, which are all fairly high, none of the smaller islands or islets is at all glaciated. Christoffersen and Larsen have some highland ice and Saddle Island has a small cliff glacier on the southern face of its larger peak (Plate XXV, figs. 1, 3). On Fredriksen Island there are a few patches of permanent snow (Plate XXIII, fig. 1) and steep rocky islets such as the Inaccessibles have light snow-caps (Plate XXIV, fig. 1).

PHYSIOGRAPHY, WITH A NOTE ON ROCK JOINTS

Pirie[2] remarks that "the South Orkneys present the features of a dissected upland, whose main outlines probably owe their origin to glacial action when the land stood at a higher level, although the present-day rock features are largely the result of sub-aerial weathering, and the rock-shattering action of frost". The main features of the topography, however, have not been produced by the action of the existing glaciers but by that of a heavier and more extensive glaciation in the past. The detached or partially detached ice formations which exist on the South Orkneys to-day are thin and press lightly on the land except along the coast, and from Pirie's observations[3] they would appear to be largely at a standstill or possessed of an extremely slow forward motion. In a few there is evidence of slight retrogression within recent times. Of the former heavier and more extensive glaciation evidence is not wanting. According to Pirie[4] "the whole outline of Laurie Island is suggestive of ice action and sculpturing on a scale much greater than that which the present-day glaciers could accomplish", while the existence of numerous *roches moutonnées* and islands of rounded outline all round the coast is evidence that the glaciers once extended far beyond their present limits. Incidentally, in these glacier-rounded islands he finds strong evidence of a former extensive depression of the land mass, for he states that the glaciation of an island like

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[1] *The Voyage of the 'Scotia'*, p. 330.

[2] Pirie, J. H. Harvey, 1913, *loc. cit.*, pp. 837 and 853.

[3] *Ibid.*, pp. 849 and 853.

[4] *Ibid.*, p. 853.

Delta Island, which is ninety feet in height, could not have been accomplished unless the land had stood at a considerably higher level than it does to-day.

In discussing the physiographical development of the main outer row of the South Shetland Islands Holtedahl[1] states that the marked transverse ridges of Livingstone Island, ridges separated by wide trough valleys, are features that only glacial erosion can produce, while there is no doubt that the sounds which separate the islands were formed by transverse glacial erosion and must therefore have once been filled with glacier ice. For the South Orkneys, a row of islands also separated by sounds and having, in Laurie Island particularly, transverse ridges enclosing deep embayments, he says it may be natural to assume a somewhat similar physiographical development.[2] Yet there, as in the South Shetlands, the topography cannot be explained without assuming a previous higher stand of the land[3] during the time when the present sounds and bays were ice-filled. "The outline of Laurie Island" he writes "reminds one strongly of the outline of the upper part of a mountain where glacial erosion has been at work in a series of folded sediments where rocks of varying hardness are represented. No doubt very recent marine abrasion has done its work, as proved by islands and rocks near the coast, yet the main topographical features have been worked out by glacial erosion." In contrast to that of Laurie Island the coast of Coronation Island although irregular is not deeply indented by bays; yet as Holtedahl remarks, a further subsidence of Coronation Island, causing the glaciers to retreat, would evidently produce an outline with deep transverse embayments resembling those of its eastern neighbour.

The major movement associated with the physiographical development of the South Orkneys has thus been one of subsidence; yet according to Pirie[4] the latest earth movement, in Laurie Island at any rate, has caused elevation to the extent of about fifteen feet, for at that height various raised beaches and sea caves are found around its coast.

Although the main topographical features as we have seen are the result of an older and more extensive glaciation, it does not follow that the action of the existing glaciers is negligible. On the contrary some of them at least would appear to be responsible for considerable sculpturing of the rocky under-mass. It has already been mentioned that one of the most commonly occurring glacier forms in the Graham Land-South Orkney region is the so-called "ice-foot" glacier of Nordenskjöld, a low, and generally narrow, fringing platform, or coastal band of ice, separating the sea from the steep mountain walls behind. It commences typically in an ice-slope curving sharply down from the high land but soon flattens out into the characteristic platform below and terminates in an ice-cliff which at the South Orkneys is often above 100 feet in height. The front or terminal ice-cliff is neither pushed out to sea nor set back any distance on the solid land, but so rests on the shore that its base is often awash at high tide. At the South Orkneys the glaciers of this type are characterized by the steepness and generally by the high elevation of their initial ice-slopes; they are also largely circumscribed, being cut off from their neighbours by rock ridges running athwart the line of the coast. In the sounds and straits of the Palmer Archipelago on the contrary they cut sharply back into the lower part of the high land behind, so that the steep initial slope is often absent or ill-defined. They are characterized by their more regular shelf-like appearance and great lateral development, the coasts for mile after mile being fringed by ice-platforms unbroken by any rock. In his valuable account of the physiography of the Graham Land region Holtedahl[1] believes that ice formations of this kind must, by plucking, cut down and backwards into the high land and carve out in the rock on which they rest low forelands akin in structure to the rocky forelands or "strandflats" of the Norwegian west coast. "Now" he says "as to the character of the *surface of the solid underground beneath the ice* there is only one natural conclusion to be drawn, viz. there must exist a low foreland corresponding to the foreland ice sheet in front of the high part of the islands". For such foreland glaciers, responsible in his opinion for the low coastal rock platforms on which they rest, Holtedahl proposes the name "strandflat" as being more appropriate than Nordenskjöld's "ice-foot" glaciers.

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[1] Holtedahl, O., 1929, *On the Geology and Physiography of some Antarctic and Subantarctic islands*, The Norwegian Antarctic Expeditions, 1927–8, 1928–9, No. 3, pp. 94–7, text-figs. 38 and 39.

[2] *Ibid.*, pp. 101–2.

[3] This would seem to be demonstrated, he says, as far as the South Shetlands are concerned, by the very marked planes of abrasion, indicated by shallow soundings, which characterize the submarine relief to the north of the islands. Compare the shallow soundings which extend for seventy miles south of Laurie Island (see p. 336).

[4] Pirie, J. H. Harvey, 1913, *loc. cit.*, p. 852.

Turning now to the South Orkneys we find that in Laurie Island, where it is evident from Pirie's[2] description and diagrams that most of the glaciers belong to this type, there can be little doubt that glacial erosion with formation of strandflats is taking place on a considerable scale to-day. That it is evidently taking place on the east and parts of the south coast of Coronation Island as well is shown by Plate XIX, figs. 1, 2, 4, and more particularly by Plate XV, figs. 1, 2, which illustrates small but well-developed ice platforms in front of the high land on the southern side of Coronation Island. Comparing the two localities, Palmer Archipelago and the South Orkneys, we find that this characteristic physiographical development which is taking place in both has apparently proceeded farther in the first than in the second; for the continuity, the relative flatness, and general shelf-like appearance of the foreland glaciers of the Palmer Archipelago, in contrast to the lateral constriction and steeper initial grade of the South Orkney glaciers, suggest that the former have already cut deeper into the underlying rock. Thus if the ice were to melt in the region under consideration we should probably find at the South Orkneys, particularly in Laurie Island, a system of detached coastal platforms, none of very great lateral extent, and none as yet cut sharply into the mountains behind; whereas in the Palmer Archipelago there would be seen continuous low forelands of great lateral extent meeting the high land behind at a sharp angle. Developing under climatic conditions that are largely the same for both localities it is possible that in time the South Orkney strandflat glaciers will come to resemble those found in the Palmer Archipelago to-day; that the dividing ridges which now separate her glaciers and prevent their lateral expansion will slowly become worn down and eventually disappear through exposure to freeze and thaw action and the undermining of the ice on either side; and with the gradual disappearance of their constricting walls adjoining glaciers will coalesce to form fringing ice platforms of increasingly greater frontage. Such a development would already appear to have taken place in some measure on the east coast of Coronation Island, for there, projecting through relatively broad stretches of ice, various nunataks appear, isolated rock pinnacles that represent perhaps the remnants of former dividing ridges (see Plate XXI, fig. 1).

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[1] Holtedahl, O., 1929, *loc. cit.*, pp. 14–22, text-figs. 4 and 6.

[2] Pirie, J. H. Harvey, 1913, *loc. cit.*, pp. 838–9, text-fig. 1.

NOTE ON ROCK JOINTS. As far as we are at present aware the most commonly occurring rocks are (1) sediments of several kinds, principally greywackes, found mainly in the eastern portion of the group on Laurie, Saddle and Fredriksen Islands, and (2) highly metamorphic gneissose rocks confined apparently to the western portion, to Signy Island and certain parts of Coronation Island. The Inaccessibles in the extreme west appear to be composed of greywacke. According to Pirie[1] the typical rock of Laurie Island is a fine-grained, almost homogeneous greywacke of a blue-grey or greenish grey colour traversed irregularly by thin quartz or calcite veins. Bedding on the whole is indistinct, the rocks being massive in character and much traversed by cracks and faults which give them a shattered appearance. In certain cliff faces the rock shows well-marked jointing, often very difficult to distinguish from bedding planes.

Shattering and jointing such as Pirie describes were seen by us at most of the localities we visited from Wilton Bay westwards to the Inaccessibles. They are evidently of wide occurrence, not only on Laurie Island but throughout the group as a whole, and would appear to be largely responsible for certain peculiarities of cliff formation on the coasts. Along the eastern side of Wilton Bay for example there are vertical cliffs and steep headlands rising to 200 or 300 feet above the sea. The rock is a greywacke much traversed by cracks and joints, the latter in most instances vertical or nearly so, and varying from a few inches to several feet in width. Near the water-level, where the vertical fissures are most conspicuous, wave and possibly ice action have evidently played a considerable part in excavating and widening them, for through some it is possible to take a ship's boat. In other parts of Laurie Island remarkable formations such as the great vertical spires or teeth of rock at Cape Hartree (Plate XXIII, fig. 3) and similar jagged, although less imposing, structures on the northern coast, while perhaps reflecting in a measure the steep angle at which these sedimentary beds are said to be inclined, may well be associated with vertical jointing, such as has been described, in conjunction with freeze and thaw action in the joints. At Cape Hansen on the south coast of Coronation Island, certain rock faces have clearly been produced by vertical jointing with subsequent flaking off of considerable portions of the rock. The rock is gneissose and traversed profusely by parallel vertical fissures up to four or five inches in width. Some are open, others occupied by bands of secondary quartz. The buttress behind the cape rises for upwards of 400 feet by a series of stepped platforms, each backed by a more or less smooth and vertical rock face.

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[1] Pirie, J. H. Harvey, 1905, *On the Graptolite-bearing Rocks of the South Orkneys*, Proc. Roy. Soc. Edin., XXV, part VI, pp. 463–8.

Near the 400-foot level there is a prodigious precipice, evidently a joint face, rising vertically for nearly 200 feet. At the base of the buttress there is a considerable accumulation of rubble or detached rock fragments, each showing at least one smooth, flat face. In the far west the greywacke of High Island, the largest of the Inaccessibles, is much shattered by steeply inclined fissures. The island is split in two by a great cleft, thought to be the result of wave or ice action in a vertical joint. The cleft is forty yards wide with high, almost vertical walls and deep water in between.

VEGETATION, WITH A NOTE ON KELP

The few plants these islands support are confined largely to the ice-free portions of the sea-board. There, beyond the ravages of the penguins, various mosses and lichens grow on the lower mountain slopes which reach the sea and on the rocky headlands and buttresses of the coast; in spite of the rigorous conditions of their environment they contrive to maintain themselves with a surprising measure of success. In the neighbourhood of the penguin rookeries a green alga (*Prasiola*) flourishes with some vigour. On the whole the vegetation is meagre, and the sites on which it achieves any degree of profusion are limited both in number and extent owing to the prevalence of snow and ice and the precipitous nature of the terrain. In certain particularly well-favoured localities the mosses attain a luxuriance of growth and richness of verdure strangely at variance with one's first impressions on approaching the group. For at first sight these islands appear to be so frigid and barren, so incapable of supporting any but the most meagre of floras, that the presence of these rich carpets of moss, perhaps half an acre or more in extent, is a source of much astonishment.

The richest and largest patches of vegetation occur on the southern side of the group, for there suitable ice-free sites are more numerous than elsewhere. As we have already seen, the southern side, though exposed to the cold south and south-east winds, is largely beyond the influence of the frequent and often violent north-westers, which warm as they are nevertheless seem to be associated with the extensive glaciation of large tracts of the northern side of Coronation Island (see p. 362). Thus it is on Signy, the southernmost yet least glaciated island of the group, especially on the gentle slopes behind the old whaling station, that the most luxuriant moss growth of all is found.

So far as is known at present[1] the flora is poorer in individual species than that of the South Shetlands and the north-western coast of Graham Land, both of them localities which lie nearer the Pole than the South Orkneys. Disregarding Weddell's doubtful record of "a patch of short grass" at Cape Dundas in 1823, neither of the two flowering plants, *Descampsia antarctica* (Hook.), Desv., and *Colobanthus crassifolius*, Hook. f. var. *brevifolius*, Eng., which are known from the South Shetlands and Graham Land, have as yet been found at the South Orkneys; and while as many as eighty-eight lichens and fifty-two mosses are known from the Antarctic as a whole, the bulk of them from Graham Land and the South Shetlands, so far only eleven lichens and fifteen mosses have been recorded from the South Orkneys. Of the fifteen mosses *Rhacomitrium lanuginosum* (Hedw.), Brid., is recorded by Mr H. N. Dixon for the first time from the Antarctic in the collections of the R.R.S. 'Discovery II' (see Appendix II, p. 380). No Hepatics are known from the South Orkneys though several have been found in the Graham Land region.

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[1] See Brown, R. N. Rudmose, 1912, *The Problems of Antarctic Plant Life*, Scientific Results of the 'Scotia' 1902–4, III, pp. 8–11.

The chief cause of the relative poverty of the flora is the climate, which as we have seen is an unusually rigorous one and more characteristic of a higher southern latitude.

With Rudmose Brown[1] I am inclined to think that Weddell's grass, the only record of a flowering plant at the South Orkneys, was the olive-green *Usnea melaxantha*, a widely distributed lichen which grows luxuriantly at Cape Dundas and elsewhere throughout the group up to heights of a thousand feet at least. It covers the rocky ground for acres with a close shaggy growth, which from a distance at any rate may readily be mistaken for grass. Dumont D'Urville,[2] however, whose scientific observations appear to have been recorded with commendable restraint, was not so misled when off the north-eastern corner of Laurie Island in February 1838. On the rocky coast not very far from Cape Dundas he observed considerable patches of green vegetation which he said "doit appartenir à la famille des lichens, peut-être à l'*Usnea melanoxantha*". Rudmose Brown suggests the further possibility that Weddell's grass, having been casually introduced perhaps by the wind, may have succumbed in a short time to the severity of the climate or been trampled out of existence by the penguins that frequent the cape; but at the same time he points out that since Cape Dundas lies in the extreme east of the group, it is therefore the least likely place for wind-borne seeds to be deposited in a region where the prevailing winds are westerly.

NOTE ON KELP. Kelp has been said to exist at the South Orkneys, but whether it is actually *Macrocystis pyrifera* or another large weed of similar habit and external characters, is uncertain. D'Urville[3] saw "paquets d'un *Fucus*" floating about off the north-western corner of Coronation Island in February 1838 which he described as approaching "la forme des *Laminaria pyrifera*, mais dont les vésicules sont axillaires et plus petites au moins de moitié que celles de l'espèce que je viens de nommer"; Larsen[4] states that he passed much drifting kelp close to the north coast of Laurie Island in November 1892. Rudmose Brown, who collected widely on Laurie Island in 1903–4, found no attached or floating kelp, and none was observed by us during the survey of January 1933. Among the Scotia's material, however, there was a fragment of a weed, picked up near the surface in Scotia Bay. This was first identified as *Lessonia grandifolia*,[5] a giant kelp-like weed from Cape Adare and Coulman Island, whose laminae are twenty-four feet in length. The South Orkneys fragment was later assigned to a separate species, *L. simulans*. Similar plants were discovered at South Georgia and Graham Land by Skottsberg,[1] who assigned them to a new genus, *Phyllogigas*, and believing them to be identical with the South Orkneys-Victoria Land specimens united all as a single species, *P. grandifolius*. Although Skottsberg's generic name has now been adopted for the South Orkney fragment in the *Marine Algae of the Scottish National Antarctic Expedition*, it is still regarded there as a separate species, *P. simulans*. Thus although no actual *Macrocystis pyrifera* has been described from the South Orkneys there can be little doubt that a large weed superficially resembling kelp exists in the neighbourhood of the group, but there seems to be considerable divergence of opinion as to what it actually may be. Clearly it is not abundant, or is at any rate rarely seen at the surface, so that it can be disregarded altogether as an aid to navigation. The *Lessonia grandifolia* from Cape Adare was brought up on an anchor in eighteen fathoms of water. It is characterized by the great length of its laminae, and, in contrast to the long and powerful stems of *Macrocystis pyrifera*, by the extreme shortness and comparative weakness of its stems, which except in very shallow water are quite incapable of bearing the laminae to the surface despite their abnormal length. If this, then, is the plant which grows at the South Orkneys, it is evident that its habitat is the sea bed where the water is fairly deep, and that it can scarcely ever appear at the surface except when torn from the bottom by icebergs or by storms of exceptional violence.

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[1] Brown, R. N. Rudmose, and Darbishire, O. V., 1912, *The Botany of the South Orkneys*, Scientific Results of the 'Scotia' 1902–4, III, p. 24.

[2] D'Urville, D., 1842, *loc. cit.*, p. 131.

[3] *Ibid.*, pp. 135–6.

[4] See Aagaard, B., 1930, *Fangst og Forskning i Sydishavet*, I, p. 46 (Oslo).

[5] See Gepp, A., and Gepp, E. S., 1912, *Marine Algae of the Scottish National Antarctic Expedition*, Scientific Results of the 'Scotia' 1902–4, III, pp. 75–7, plate i, figs. 6–7, and also Gepp, A., and Gepp, E. S., 1907, National Antarctic Expedition, 1901–4, *Marine Algae, I—Phaeophyceae and Florideae*, pp. 1, 3–7, plates i–ii.

It has often been stated that the absence of kelp and other large sea-weeds from the littoral and sublittoral zones of high southern latitudes is due to the grinding action of pack-ice as it works against the land, and if this be true it is highly improbable that any could exist at the South Orkneys, which are subject to complete envelopment by pack-ice for a longer or shorter period every year. Moreover, if kelp is absent from the South Shetlands, as it appears to be, it is all the more likely to be absent from the South Orkneys which on the whole are liable to severer ice action than the South Shetlands. And yet, as Kemp suggests,[2] there may be other reasons for the absence of kelp from these regions; for although pack-ice would no doubt completely destroy the plants that might grow between tide marks or in the very shallow water adjoining, it could not, unless it were rising and falling on a heavy swell, destroy any but the distal laminae of those that might be anchored in the deeper water beyond. Indeed, it is not inconceivable that in very calm conditions pack might pass over offshore kelp without doing it any great harm, although conversely much no doubt would be destroyed if the weather were very rough. It would seem, then, that ice need not bring about the total destruction of kelp that it is said to do, and that if other conditions were favourable to its growth some at least must escape. As we saw for ourselves in January 1933 other algae very much smaller and more fragile than kelp contrive with a considerable measure of success to maintain a footing in the littoral zone in places where they are unlikely to escape periodic destruction by ice; their continued existence on these sites would appear to depend largely on their capacity to re-establish themselves from deeper water after the ice had cleared away.

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[1] Skottsberg, C., 1907, *Zur Kenntnis der subantarktischen und antarktischen Meeresalgen. I. Phaeophyceen*, Schwedische Südpolar-Expedition, 1901–3, IV, No. 6, pp. 63–9.

[2] Kemp, S., and Nelson, A. L., 1931, *loc. cit.*, p. 158.

The apparent absence of kelp from these islands is perhaps due to the low temperatures of the water characteristic of this and other similar localities from which it is known to be absent. According to information kindly supplied by Mr G. E. R. Deacon the surface temperature at South Georgia (where kelp is so abundant), even in the open sea, does not fall below −1° C. for more than three months in any normal year, while close inshore it may reach a maximum of 3·6° C. in January to February. At the South Orkneys, owing to the influence of the Weddell drift, considerably colder conditions prevail, though in summer they may be subject to some variation according to the presence or absence of pack-ice in the surrounding seas. Deacon[1] shows the −1° C. surface isotherm in November–December 1931 as passing well to the north of the group. Even in February, the warmest month, if there is much ice about, very low temperatures are possible. Between February 14 and 17, 1931, the surface temperature in Sandefjord Bay varied between −0·5° and −1·5° C., the average being about −1·0° C. Moreover even when the islands are ice-free the surface temperatures never seem to rise very far above zero. Throughout January 1933, a month marked by the complete absence of pack-ice and by more than the ordinary amount of sunshine, the surface temperature all round the group rarely rose above 1° C., and for the greater part of the period it was either below or about 0·5° C.

SEALS

With the exception of the sea lion, whose habitat is in a warmer climate, all the known species of southern seals, the elephant, leopard, Weddell, Ross and fur seals have from time to time been recorded at the South Orkneys; and all except the last, which is now thought to be extinct in the more southerly dependencies of the Falkland Islands, are known to inhabit or visit the group at the present time.

The Fur Seal (*Arctocephalus australis*, Zimm.)

Although the fur seal that once crowded the South Shetland beaches were all but exterminated between 1820 and 1822,[2] the scattered survivors being afterwards left in comparative peace were able to multiply afresh and the stock increased to an extent that gave fair promise of complete recovery. Fifty years after the initial slaughter another generation of sealers visited the South Shetlands, and so far had the seal re-established themselves that between the season 1871–2 and 1891 at least 18,000 fur sealskins were taken from various parts of the group.[3] From this second catastrophe they were never allowed to recover, and their final extermination is believed to have taken place in the opening years of the present century. The last authentic capture occurred in 1902[1] when the Swedish expedition found a single fur seal on Nelson Island. Since then, as far as we know, none has been recorded from the group.

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[1] Deacon, G. E. R., 1933, *A General Account of the Hydrology of the South Atlantic Ocean*, Discovery Reports, VII, p. 183, fig. 8.

[2] Weddell (*loc. cit.*, *supra*, p. 141) estimates that during the years 1821 and 1822 320,000 were killed.

[3] See Jordan, D. S., 1899, *The Fur Seals of the Pribilof Islands*, part III, p. 314 (Washington); also Matthews, L. H., 1931, *loc. cit.*, *supra*, p. 83.

In view of the extensive sealing that was in progress at the South Shetlands in the early part of last century it is rather surprising that the discovery of a neighbouring group, to all appearances a likely haunt of fur seal, should have been singularly unproductive of these valuable animals; for compared with the vast number of skins that were taken from the South Shetlands the produce of the South Orkneys was negligible, or so at least it would appear from the records of capture which have as yet been traced. Even if we ignore these records, for although reliable they are admittedly very scanty, and suppose for the moment that fur seal did once exist on the South Orkneys in numbers sufficient to attract the South Shetland sealing fleet, the sealers would doubtless have left some record which would be traceable to-day. There is no evidence, however, that such operations ever took place. Although in those days, as now, sealers were inclined to be vague and secretive as to their hunting grounds, many details of the butchery at the South Shetlands survive. Had a similar massacre occurred at the South Orkneys it is scarcely conceivable that it could have passed unnoticed. So far as they have been traced the landings effected by sealers on the South Orkneys during last century are few and far between, fairly conclusive evidence, it is felt, that the group was regarded with indifference and can never have offered great prospect of commercial reward.

The scarcity of fur seals at the South Orkneys, as indicated by the records of the sealers and others who are definitely known to have visited the group last century, is shown below.

Date	Authority	Fur seals	Localities examined closely
December 1821	Powell Palmer	None	Sandefjord Bay district, eastern part of north coast of Coronation Island, Lewthwaite Strait, western end of Laurie Island, and Ellefsen Harbour district
February 1822	Weddell	Apparently none	Probably north-western corner of Coronation Island
January 1823	Weddell Brisbane	3	Saddle Island, Sandefjord Bay district, Cape Dundas district, the southern coasts of Laurie and Coronation Islands, and Ellefsen Harbour district
January 1838 February 1838	D'Urville	None	Weddell Island
January to February 1874	Dallmann	165	Sandefjord Bay district, south-western end of Coronation Island, and southern end of Lewthwaite Strait
November 1892	Larsen	None	Either Brown or Macdougal Bay on north coast of Laurie Island and apparently Palmer's Bay on north coast of Coronation Island

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[1] Brown, R. N. Rudmose, 1913, *The Seals of the Weddell Sea: Notes on their Habits and Distribution*, Scientific Results of the 'Scotia' 1902–4, IV, part XIII, p. 186.

During the two years that followed the discovery of the group fur seals would appear to have been exceptionally scarce, judging from the records of Powell, Palmer and Weddell, who between them seem to have examined most of the localities where the species might be expected to congregate. Yet in the fifty and odd years that elapsed between the departure of Weddell and the arrival of Dallmann the seal would appear to have established a slight footing in various parts of the group, evidently in the very localities, Sandefjord Bay and Lewthwaite Strait, that we know to have been examined without success by Powell and Palmer. Dallmann does not state precisely where his boats landed, but as nearly as we can judge his best hauls, amounting to 145 skins in all, were obtained somewhere in the neighbourhood of Sandefjord Bay. A proportion of these skins may, however, have been obtained on the south coast of Coronation Island, slightly to the eastward of Return Point, and had there been a fur seal rookery there in December 1821 Powell may have missed it, because he did not examine this locality closely although he saw it in the distance from Return Point.

Although Dallmann appears to have slaughtered every fur seal he could lay hands on and is the last to record its presence on the South Orkneys, it is by no means certain that it was he who exterminated the species there. His search covered only a small part of the group and it is thought that one or other of the many localities which he did not visit may have been frequented by fur seals after his departure. On this assumption the final extermination must have been the work of others who have left no record of their handiwork. It may have happened, as already suggested (pp. 317, 319), during the secondary revival of sealing at the South Shetlands which came to an end about 1891, or even later at the hands of Canadian sealers in the closing years of last century.

It is difficult to account for the scarcity of the fur seal on these islands; for as a breeding ground they would appear to offer just as many attractions as the South Shetlands. In their climate and geographical position the South Orkneys and the South Shetlands are strictly comparable and like the latter the South Orkneys possess a number of sites where the seal might readily have hauled out. The best of these are to be found on Signy Island, where, it is interesting to note, more elephant seal are found to-day than anywhere else in the group. Elsewhere, to mention a few of the more likely sites, there is suitable ground on Michelsen Island, Fredriksen Island, the Beach at Scotia Bay, and also in the neighbourhood of Sandefjord Bay and near Cape Hansen in Normanna Strait. The South Orkneys differ from the South Shetlands, however, in one important respect: they are surrounded by pack-ice for a longer period every year. Throughout November, with rare exceptions, often until late December and sometimes even until well into January, the coasts of the South Orkneys are heavily blocked by ice, while at the South Shetlands they are generally quite clear by the middle of November at least, and occasionally before. Weddell,[1] describing the periodic intercourse that the South Shetland fur seal used to have with the land, states that "The males of the largest size go on shore about the middle of *November*, to wait the arrival of the females, which of necessity must soon follow, for the purpose of bringing forth their young. These, in the early part of *December*, begin to land; and they are no sooner out of the water than they are taken possession of by the males, who have many serious battles with each other, in procuring their respective seraglios." Had they tried, then, to reach the South Orkneys in November and December, it is clear that unless they were capable of travelling long distances over sea-ice the seal must generally have been seriously handicapped or held up altogether by the pack which blocked the coasts. This would appear to be the only possible explanation of the scarcity of the species on these islands. It is interesting to note in this connection that even at the height of the slaughter at the South Shetlands, the southern side of the Bransfield Strait, which like the South Orkneys is usually blocked by ice in November and December, appears to have been equally unproductive of fur seal. Indeed, as far as I am aware, there is no record that any were ever captured there.

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[1] Weddell, J., 1825, *loc. cit.*, *supra*, p. 138.

Elephant Seal (*Mirounga leonina*, Linn.)

The elephant seal, although very far from plentiful, is found in moderate numbers on the South Orkneys to-day. As far as our scanty evidence shows it would appear to have been even less plentiful in the past. At one time it used to frequent the South Shetlands in vast numbers, and for the sake of the oil it yielded perished in thousands along with the fur seal during the wanton destruction of 1820–2.[1] So heavy had the slaughter of elephant seal been that when the 'Chanticleer' arrived at the South Shetlands in 1829 not one was to be seen,[2] although no doubt the species still survived, as did the fur seal, on various out-of-the-way sites unfrequented by sealers. Offering a relatively small commercial reward it escaped extermination and is to be found to-day in some parts of the South Shetlands, particularly on Elephant Island where several hundred were seen by the Shackleton-Rowett expedition[3] in the autumn of 1922. For all its former abundance at the South Shetlands the early sealers between 1821 and 1823 do not record a single elephant seal at the South Orkneys. The earliest record of its presence there dates from January 1874, when Dallmann landed and found it established in some strength at or very near Sandefjord Bay. Dallmann unfortunately does not give figures, merely stating that many elephant seal were seen of which all were evidently killed. Since then it has apparently not been found in numbers at the South Orkneys until within comparatively recent times. None was seen by Larsen on the northern side of the group in November 1892 and none by the Scottish expedition on Laurie Island in 1903–4. Laurie Island, perhaps, has never been much frequented by this animal. A seal, thought to have been an elephant, was sighted near Saddle Island on February 4, 1903, and a young bull elephant 13½ feet long came ashore in the neighbourhood of the meteorological station on April 11, 1904;[4] but throughout the whole period of the

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[1] See *A Voyage towards the South Pole*, pp. 134, 141.

[2] Webster, W. H. B., 1834, *Narrative of a Voyage to the Southern Atlantic Ocean in the years* 1828, 1829, 1830, II, pp. 157, 276 (London).

[3] See Wild, F., 1923, *loc. cit.*, p. 163.

[4] Brown, R. N. Rudmose, 1913, *loc. cit.*, p. 186.

Argentine occupation of Scotia Bay it seems to have been an infrequent visitor,[1] except apparently during the extraordinarily ice-free year of 1908, when according to Mossman[2] elephant seals were observed in March, October and November.

The congregating of elephant seal on the South Orkneys in modern times was apparently first noted in the report on the whaling season 1914–15. In that report[3] it was stated that in Borge Bay, Signy Island, large numbers of elephant seal came ashore to sleep. Moreover, although the number was not stated it was evidently considerable, since the writer was of the opinion that "one season's thinning of the males would not apparently be hurtful to the existence of this animal".

In January 1933 the number of elephant seal hauled out on the South Orkneys was estimated to be about 296, of which all except seventy-four were found on Signy Island. The occurrence of such relatively large numbers on that island is hardly surprising, for as already suggested it is by far the most likely part of the group on which the seal might be expected to congregate. Not only are suitable beaches, with low ground behind them, common around its coast, particularly in Borge Bay, but the sheltered situation of the island as a whole may be thought to add considerably to its attraction for elephant seal. At the time of our visit groups of seal totalling upwards of 100 individuals were scattered around the shores of Borge Bay. There is evidence, however, that greater numbers may visit this locality. On the flat land to the west of the whaling station just behind the shore there are a number of elephant wallows, and the whole appearance of the ground there suggests that it has been occupied within recent years by a rookery or rookeries of considerable size. Of all the available sites in the South Orkneys Borge Bay would appear to be that most frequented by elephant seal.

The distribution of elephant seal on the South Orkneys in January 1933 is shown below. All the figures are approximate.

Locality	Number
Ellefsen Harbour: on either side of the narrow neck separating Michelsen and Powell Islands	50
Coronation Island: Sandefjord Bay	24
Signy Island: Borge Bay	100
Paal Harbour	60
Point Jebsen	12
North coast in Normanna Strait	50

A rough analysis of the age and sex composition of the seal was made at Borge Bay, Ellefsen Harbour and Sandefjord Bay. Of a total of 174 approximately seventy-one were adult bulls, none exceptionally large, and fifteen were adult cows. Of the remaining eighty-eight, which were immature bulls and cows, the great majority appeared to be yearlings. The adults of both sexes were observed to be in moult. In Paal

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[1] See Passera, Gino de, 1932, *loc. cit.*, p. 357.

[2] Mossman, R. C., 1909, *loc. cit.*, p. 409.

[3] See *Report of the Interdepartmental Committee on Research and Development in the Dependencies of the Falkland Islands*, Appendix xiv, p. 110.

Harbour and on the north coast of Signy Island the seal (110 in all) were not examined so closely. At least half, however, were adults, of which the majority appeared to be bulls.

The preponderance of adult bulls and yearlings and the scarcity of adult females is noteworthy.

It was not definitely ascertained if the elephant seal breed on the South Orkneys. Although no obvious pups were seen at the time of our visit, the smaller of the immature animals may, it is thought, have been pups born very early (in late August) during the current season, 1932–3. Here again, however, we are confronted with the problem of the pack-ice; for unless the pregnant females can travel many miles over a frozen sea it is difficult to see how the elephant seal can normally breed on these islands. At South Georgia, according to Matthews,[1] the annual haul out takes place from the middle of August until the first week in September, the pups being born from the last week in August to the end of September. If we assume that the seal breed at the same time on the South Orkneys we must also suppose that they haul out over the pack-ice which in August and September may extend for fifty and even 100 miles to the north of the group. It is difficult to believe that they could normally accomplish such a long and arduous journey, and we are therefore forced to the conclusion that little if any breeding can take place on the South Orkneys. The possibility that they may breed late or out of season must be disregarded, since otherwise we should have seen unmistakable pups in January 1933. If, as seems likely, little or no breeding takes place it is probable that elephant seal visit the South Orkneys almost exclusively during the short ice-free period, and then very largely in order to sleep or for the purpose of shedding their coats. The presence of elephant seal on Laurie Island (which as we have seen is but rarely frequented by the species) in March, October and November during the extraordinarily ice-free year of 1908 suggests that in "open" years the seal may visit the group in larger numbers than usual.

The scarcity of the elephant seal on the South Orkneys, evident both to-day and in the past, like that of the fur seal is probably associated with the ice conditions which seem to render the group unsuitable as a breeding ground.

Since the South Shetlands themselves are blocked by ice during August and September the question arises as to the actual breeding time of the great herds of elephant seal which once frequented that group; for presumably they did not visit it in such vast numbers merely for the purpose of moulting. Weddell's statement,[2] that "the males come on shore about the end of August and beginning of September; and in this month, and the first part of October, they are followed by the females, which, being with young since the preceding season, choose the land at this time for the purpose of parturition and procreation", is in my opinion unsubstantiated by any evidence. Certainly Weddell himself was never at the South Shetlands in August or September. In 1823 he tried to get there in late October[3] but was blocked by heavy pack about forty miles to the north of the group. By the middle of October 1819, however, when Smith made his first landing,[1] the whole of the northern side of the group seems to have been clear of ice and "seals and sea-otters abounded, as also an animal differing from the sea-otter".[2] Nevertheless it is probably only in exceptional years that the northern coasts are clear as early as the first part of October, while the Bransfield Strait and the southern coasts are rarely if ever clear until the end of October. In view of the ice conditions, therefore, it is apparent that the breeding of elephant seal on the South Shetlands must, if it happened at all, have taken place at least a month later than it does on South Georgia to-day.

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[1] Matthews, L. H., 1929, *The Natural History of the Elephant Seal*, Discovery Reports, I, p. 236.

[2] Weddell, J., 1825, *loc. cit.*, p. 135.

[3] *Ibid.*, p. 116.

Weddell Seal (*Leptonychotes weddelli*, Less.)

At the time of the destruction of the fur and elephant seal on the South Shetlands the Weddell seal, or sea-leopard of the early sealers, also seems to have been freely taken. Although it is but little mentioned in the records of that period there can be little doubt that in the eagerness of the hunt for oil and skins it perished in large numbers wherever it was encountered, both on the South Shetlands and farther afield. "On Palmer's Land", writes Fanning,[3] "and the south part of Sandwich Land, they are found herded together in rookeries of many hundreds, and furnish oil, as the elephant, in proportion to their size." On the South Orkneys at this time it was not found in very large numbers, Powell, Palmer and Weddell between them taking only about three dozen in all; but in 1874 a fairly large number appears to have been killed by Dallmann at the south-western corner of Coronation Island and on either side of Lewthwaite Strait at its southern end. In 1892 some were seen by Larsen on the north coast of Laurie Island. In more recent times the Weddell seal has been recorded as of common occurrence, especially by the Scottish expedition[4] who found it established in considerable numbers in the neighbourhood of their winter quarters in Scotia Bay.

Locality	Number
Wilton Bay	30
Fredriksen Island	4
Ellefsen Harbour	40
Falkland Harbour	250
Signy Island	20
Sandefjord Bay	20
Inaccessible Islands: High Island	6

During January 1933 approximately 370 Weddell seals were seen on various parts of the South Orkneys. The majority were congregated in a large rookery, about 250 strong, on a stretch of rotten fast ice at the head of Falkland Harbour, the remainder, 120 in all, were hauled out singly or in groups of from two to four, and were scattered along the coasts on rocky ledges from Wilton Bay westwards to the Inaccessibles. The numbers observed and the various localities at which they were seen are shown above. All the figures are approximate.

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[1] Miers, J., 1820, *loc. cit.*, pp. 371, 372.

[2] There are of course no sea-otters in the Antarctic. Miers' "sea-otters" were probably fur seals, while his "animal differing from the sea-otter" might have been the elephant seal. His statement, however, is rather vague.

[3] Fanning, E., 1834, *loc. cit.*, p. 351.

[4] *The Voyage of the 'Scotia'*, pp. 129, 227, 340.

The total, 370, probably falls short of the actual number that were then hauled out, since some no doubt were scattered around the coast of Laurie Island which was not examined as closely as that of other parts of the group.

The Weddell seal breeds at the South Orkneys and is probably the most numerous of all the species that frequent the group. Although only a moderate number were seen in January 1933 more may visit the group at other times of the year, especially it is thought in early spring, when according to Rudmose Brown[1] female seal arrive in large numbers at the south-western end of Laurie Island and congregate in rookeries on the fast-ice near the land in order to give birth to their young. The arrival of the seal takes place during the last days of August and in early September. By the end of September all the pups are born and by the middle of October most have left their mothers. Then the male seals begin to arrive. Throughout the summer of 1903–4 the Weddell seal was a frequent visitor to Scotia Bay, often as many as a hundred being seen on a small raised beach on the western side of the bay where they had hauled out to sleep after a heavy meal.[2] In January most of them were changing their coats and this probably accounts for the big rookery that was seen in Falkland Harbour during the recent visit of the 'Discovery II'. By April, when the ice begins to become tightly packed around the coasts, the seal have practically deserted the group. They do not wholly disappear, however, for throughout autumn and winter one or two, principally males, are generally seen every month, especially on fine days, when the seal emerge from holes in the floe to lie and bask in the sun.[3] Of all the seals the Weddell is the most frequent winter visitor to the South Orkneys.

Most of the seal seen in January 1933 were adults or yearlings, but mainly the former. Both sexes were represented. There were very few pups: two were seen in Wilton Bay and six on the main island of the Inaccessible group.

Leopard Seal (*Hydrurga leptonyx*, Blain.)

In spite of its solitary and wandering mode of life the leopard seal is by no means uncommon at the South Orkneys; indeed during the summer months in particular it may even be said to be abundant. Larsen, in November 1892, seems to be the first to record its presence on the group, unless the "leopards" which Dallmann vaguely mentions in 1874 can be accepted as referring to this species. Next to the Weddell seal the leopard was the species most frequently seen in Scotia Bay throughout the summer of 1903–4.[4] In the season 1914–15 seal, said to have killed enormous numbers of penguins, were very numerous in the neighbourhood of Signy Island.[5] These were evidently the leopard seal. Throughout January 1933 leopard seal were commonly seen swimming about in bays on the southern side of the group. In Wilton Bay alone above forty were seen and nearly as many more in Sandefjord Bay. These are exceptionally large numbers for an animal which as a rule is encountered only singly. The total number in the neighbourhood of the islands is thought to have been a fairly large one, how large it is difficult to say, since only a few of the bays, in which the seal appear to have been plentiful, were searched closely for them. Surprisingly few were encountered out of the water. One was seen on a rock and two on a fragment of glacier-ice in Wilton Bay, while a few were hauled out in Paal Harbour and on the fast-ice in Falkland Harbour.

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[1] *The Voyage of the 'Scotia'*, pp. 129–31.

[2] *Ibid.*, p. 227.

[3] *Ibid.*, pp. 92, 122, 329, 331, 334, 336.

[4] *Ibid.*, p. 227.

[5] See *Report of the Interdepartmental Committee on Research and Development*, p. 110.

The leopard seal was seen once or twice in late winter by the Scottish expedition.[1]

It is not known if the leopard seal breeds on the South Orkneys. All that were seen during our recent visit appeared to be adult. On November 19, 1903, a young leopard was seen by W. S. Bruce on Point Thomson in Brown Bay.[2] At South Georgia Matthews[3] records that the mothers come ashore to give birth, the young being born in late August and early September.

Crab-eater Seal (*Lobodon carcinophagus*, Jaquinot & Pucheran)

The crab-eater is rarely seen on the South Orkneys. It was recorded by Larsen on the north coast of Laurie Island in November 1892 (see p. 318) and in very small number by the Scottish expedition in the summer of 1903–4.[4] It was occasionally seen, also by this expedition, in the winter of 1903.[5] Two only were seen in January 1933, one on a rocky ledge on Christoffersen Island, the other in Falkland Harbour. Both were adult.

Ross Seal (*Ommatophoca rossi*, Gray)

The Ross seal, the rarest of all the Antarctic Pinnipedia, has been observed on a number of occasions at or not far away from the South Orkneys.[6] One was shot in the pack on February 6, 1903, in 60° 10′ S, 42° 38′ W. One was seen at Scotia Bay in the summer of 1903–4. In 1904, between March 27 and April 26, three more were seen in Scotia Bay, two of them ashore. In December of that year a young one was killed near Cape Burn Murdoch; it was thought to be about six weeks old and to have been born on the pack. Three more were captured in 1907.[7] The Ross seal was not seen in winter either by the Scottish expedition or the first Argentine meteorological staff.

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[1] *The Voyage of the 'Scotia'*, p. 122.

[2] Brown, R. N. Rudmose, 1913, *loc. cit.*, *supra*, p. 192.

[3] Matthews, L. H., 1929, *loc. cit.*, pp. 253–4.

[4] *The Voyage of the 'Scotia'*, p. 228.

[5] *Ibid.*, p. 122.

[6] *Ibid.*, pp. 56, 122, 228, 320, 321, 327, 350.

[7] Mossman, R. C., 1908, *The South Orkneys in* 1907, Scott. Geog. Mag., XXIV, No. VII, p. 354.

APPENDIX I

THE COLLEMBOLA

By W. MALDWYN DAVIES

The Collembola, probably more than any other order of insects, provide excellent material for the study of geographical distribution and its allied aspects. The absence of wings in this primitive order restricts migration and the delicate integument makes it extremely unlikely that these insects are carried by sea any appreciable distance. The discovery of identical, or allied, species on widely separated tracts of land, particularly islands, thus affords strong evidence of land connection. Humidity alone is the limiting meteorological factor, for ranges of temperature from the ice of Spitzbergen to the tropical heat of West Africa afford no barrier to this order. There is no doubt that if greater attention were paid to the methods and extent of collection of Collembola—insects which normally would be overlooked by collectors—the effort would be fully compensated by the results.

Our knowledge of Antarctic Collembola has been derived from collections made by the expeditions of the 'Belgica' (1897–9), the Swedish Expedition (1901–3), the 'Southern Cross' (1898–1900), the 'Scotia' (1902–4), the 'Discovery' (1901–4) and the 'Terra Nova' (1910). In addition Schaffer (1897) described several species from Tierra del Fuego. I wish, therefore, to thank Dr Kemp and Mr D. Dilwyn John for this opportunity of examining further examples of the Collembola collected by the 'Discovery II' in 1933.

The Collembola collected by this recent expedition were all the same species, namely *Cryptopygus antarcticus*, Will. The specimens were obtained from Michelsen Island, where enormous numbers occurred under stones in and near the penguin rookery; from Sandefjord Bay, Coronation Island, where a few were taken in moss and algae; from Signy Island, where they were common under stones on the coast and in small numbers at 600 feet; from Wilton Bay, Laurie Island, where they were found in crevices on the rock face at fifty feet above the sea; and from Beach Point, Thule Island, South Sandwich Islands, where specimens were taken in the washings from algae. It is of interest to record that, despite search, no Collembola were found in the cleavage cracks or under stones on the Inaccessible Islands, South Orkneys.

Willem (1902) originally described *Cryptopygus antarcticus* from Danco Land and the islands August, Harry, Brabant, Cavelier de Caverville, Bob and Wiencke. Subsequently it has been recorded by Wahlgren (1906) from South Georgia, the South Shetlands, Graham Land and Paulet Island while Carpenter (1906) has described it (probably) as *Cryptopygus crassus*, Carp., from Saddle Island and Laurie Island.

A detailed description with figures of *Cryptopygus antarcticus*, Will., is given in Willem's work (1902). One character, however, has been the subject of correction.

Willem claimed that the species possessed fourteen eyes, seven on each side of the head. Wahlgren (1906), after the examination of a large quantity of material, stated that *antarcticus* had only twelve eyes, six on each side. He figured the eyes and suggested that owing to the intense pigmentation and the reaction of this under treatment with caustic potash, Willem had mistaken for eyes the scattered oval transparent spots peculiar to this species. Carpenter (1906) described the new species, *Cryptopygus crassus*, which differed from *antarcticus* in the possession of twelve instead of fourteen eyes. Subsequently, in view of Wahlgren's observations, Carpenter (1925) has stated that in all probability his species is synonymous with *antarcticus*, Will., since the latter species is now regarded as having only twelve eyes. Dr Carpenter very kindly gave me a slide of *Cryptopygus crassus*, Carp., and although the specimens were too advanced to observe the actual number of eyes, detailed comparison upholds Dr Carpenter's opinion regarding the synonomy of this species. A careful study was made of the number of eyes of the specimens in the present collection. The difficulty of obtaining clear specimens showing the exact position of the delicate ocelli was fully experienced, but where clear mounts were obtained only twelve eyes could be discerned. Ample evidence in support of these observations was provided by the examination of young specimens which, with less intense pigmentation, left no doubt as to the number of eyes. In the circumstance therefore, unless or until other material is forthcoming verifying Willem's description of *antarcticus* with fourteen eyes, there is no justification for erecting a new species or reinstating *Cryptopygus crassus*, Carp., for the Collembola of the present collection.

The genus *Cryptopygus*, which was erected by Willem on the discovery of *Cryptopygus antarcticus*, is of particular systematic interest since it shows affinities to *Anurophorus* and *Isotoma*. Its distribution was thought to be confined to the Antarctic islands, but recently Carpenter (1925) described a new species, *Cryptopygus niger*, from Ben More, Canterbury, New Zealand. This finding is of interest for unless *Cryptopygus* is discovered later on the northern continents it must be regarded as affording further evidence of original land connections between Antarctica, South America and New Zealand. The two other species of this genus are *Cryptopygus cinctus*, Wahl. (1906), from East Falkland and Feuerland, and *Cryptopygus caecus* described by Wahlgren (1906) from South Georgia.

REFERENCES

Carpenter, G. H., 1902. *Report on Collections...of the 'Southern Cross'*, pp. 221–3 (British Museum).

—— 1906. *Collembola from the South Orkney Islands*, Proc. Roy. Soc. Edin., XXVI, pp. 473–81.

—— 1925. *Some Collembola from Southern New Zealand*, Mem. Proc. Manchester Lit. Phil. Soc., 69, 11, pp. 1–15.

Schäffer, C., 1891. *Die Collembolen von Süd Georgien*, Jahrb. Hamburg. wiss. Anst., IX, pp. 195–201.

—— 1897. *Apterygoten*, in Hamburger Magalhaenischen Sammelreisen.

Wahlgren, E., 1906. *Antarktische und subantarktische Collembolen*, Wiss. Ergebnisse der schwedischen Südpolar-exped.

Willem, V., 1902. *Collemboles*, Rapports Scientifiques, Voyage de Belgica.

APPENDIX II

THE MOSSES

By H. N. DIXON

The mosses collected—almost exclusively at the South Orkneys—comprised only ten species, nine from the group itself, the remaining one from Wiencke Island in the Palmer Archipelago. Of the nine gathered at the South Orkneys, eight had been previously collected there by Rudmose Brown and La Valette. The ninth species was *Rhacomitrium lanuginosum* (Hedw.), Brid., a species of the widest distribution, but not hitherto recorded from the Antarctic. The exact locality was not stated.[1] The prevailing moss would appear to be *Dicranum aciphyllum*, H.f. and W., which was found in two or more of the gatherings, mostly in large quantity.

The moss collected on Wiencke Island was *Drepanocladus brachiatus* (Mitt.), Dix. (Syn. *Hypnum longifolium*, Wils.), a species hitherto not recorded from the Antarctic, but widely distributed round the sub-Antarctic Zone.

None of the mosses was in fruit. The following were collected:[2]

SOUTH ORKNEYS

Rhacomitrium lanuginosum (Hedw.), Brid.

Michelsen Island. St. 1089, 3.i.33.

Andreaea depressinervis, Card. Altitude: 70 ft.

Fredriksen Island. St. 1090, 4.i.33.

Polytrichum alpinum, Hedw. Approaching var. *brevifolium* (R.Br.).

Drepanocladus uncinatus (Hedw.), Warnst.

Webera Racovitzae, Card.

Dicranum aciphyllum, H.f. and W.

Altitude: all four species up to heights of about 150 ft.

Habitat: long shallow depressions running up the dry scree slopes on the western face of the island.

Coronation Island, Sandefjord Bay. St. 1091, 9.i.33.

Brachythecium antarcticum, Card. Nearer type than var. *cavifolium*, Card. The type has not been recorded from the South Orkneys.

Altitude: up to about 100 ft.

Habitat: very wet crevices of the rock.

Remarks: there is little ground free of ice or snow in the neighbourhood of Sandefjord Bay and what there is is inclined to be soaked by thaw water from the heights above. *B. antarcticum* appeared to be the only species in this district.

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[1] The original label, on which full details of this gathering are given, has unfortunately been mislaid. *J.W.S.M.*

[2] Brief ecological notes have been added to Mr Dixon's list of determinations.

Signy Island, Borge Harbour. St. 1092, 18.i.33.

Dicranum aciphyllum, H.f. and W.

Andreaea depressinervis, Card.

Polytrichum subpiliferum, Card.

Drepanocladus uncinatus (Hedw.) forma *polaris*, Ren.

Brachythecium antarcticum, Card., var. *cavifolium*, Card.

Ceratodon antarcticus, Card. Actually this is between *C. antarcticus* and *C. grossiretis*, Card., but both are certainly forms of *C. purpureus*.

Webera Racovitzae, Card.

Altitude: all seven species at 350 ft.

Habitat: damp sheltered slope.

Polytrichum alpinum, Hedw.

Altitude: 300–400 ft.

Habitat: arid plateau on which it was the only species.

PALMER ARCHIPELAGO

Wiencke Island, Port Lockroy. 23.i.31.

Drepanocladus brachiatus (Mitt.), Dix. (Syn. *D. longifolius* (Wils.).)

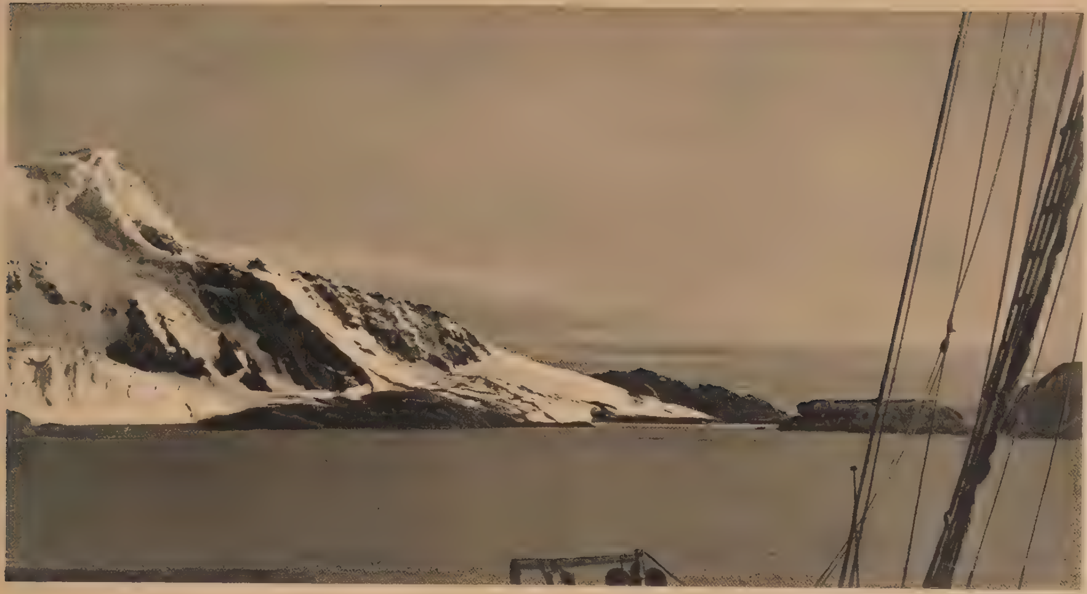
PLATE XII

Site of Powell's landing, the Meteorological Station,
and wreck of the 'Tioga'

Fig. 1. Coronation Island, south-western corner, showing Sandefjord Peak, and on the right the narrow channel between Spine Island and the mainland. On the gently sloping ground in the centre of the picture George Powell made the first landing on the group. Note the heavy accumulation of rime on the summit of Sandefjord Peak.

Fig. 2. Laurie Island, the Beach, showing the Argentine Meteorological Station. View from Scotia Bay looking across to Uruguay Cove.

Fig. 3. The wreck of the 'Tioga' factory ship near Point Jebsen, Signy Island. Note the pack-worn boulders on the shore.



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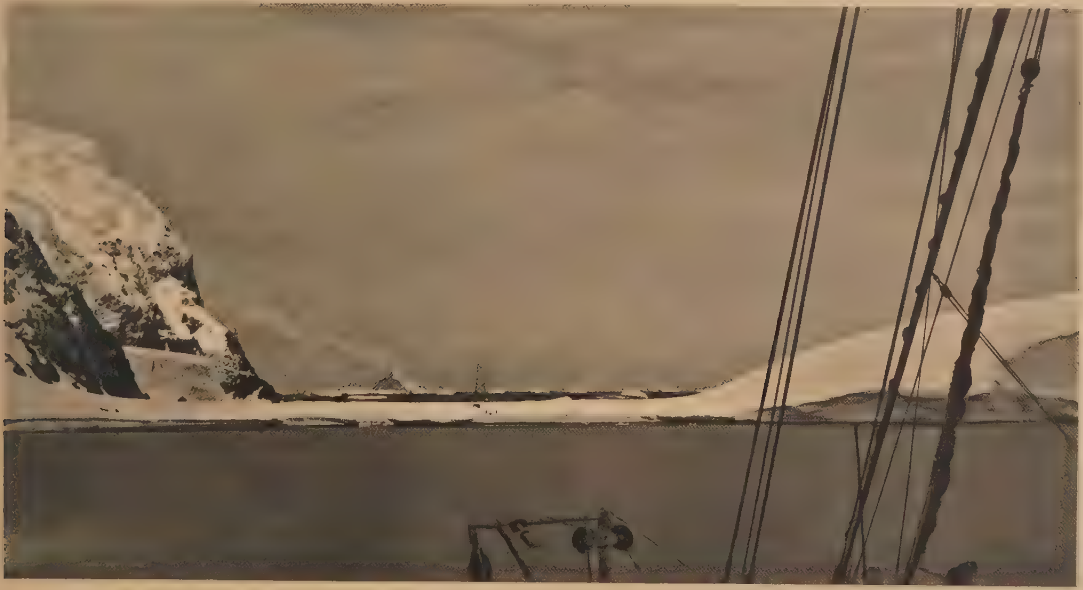

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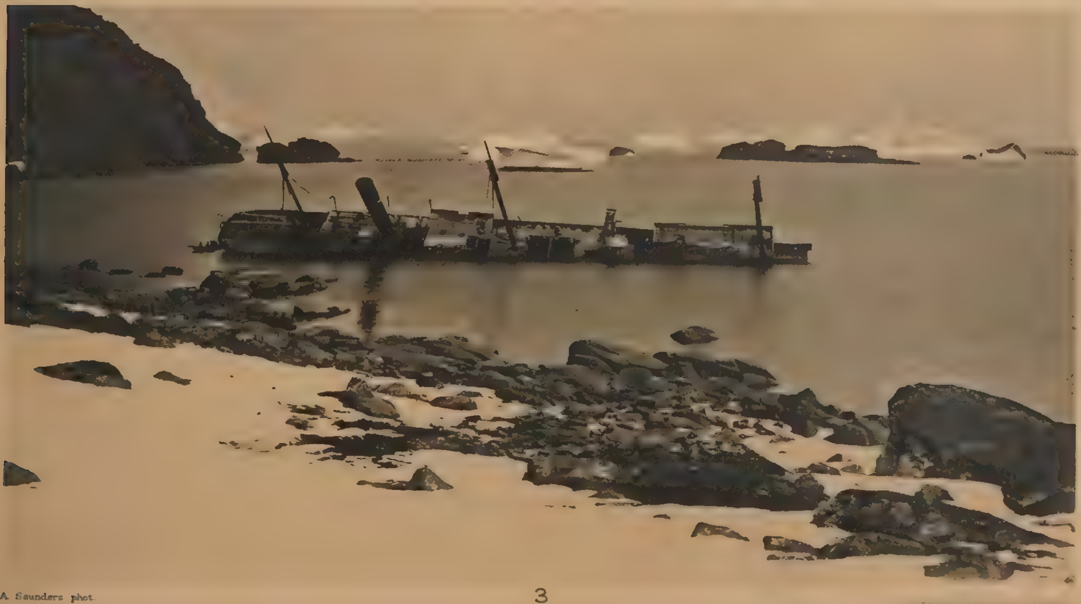

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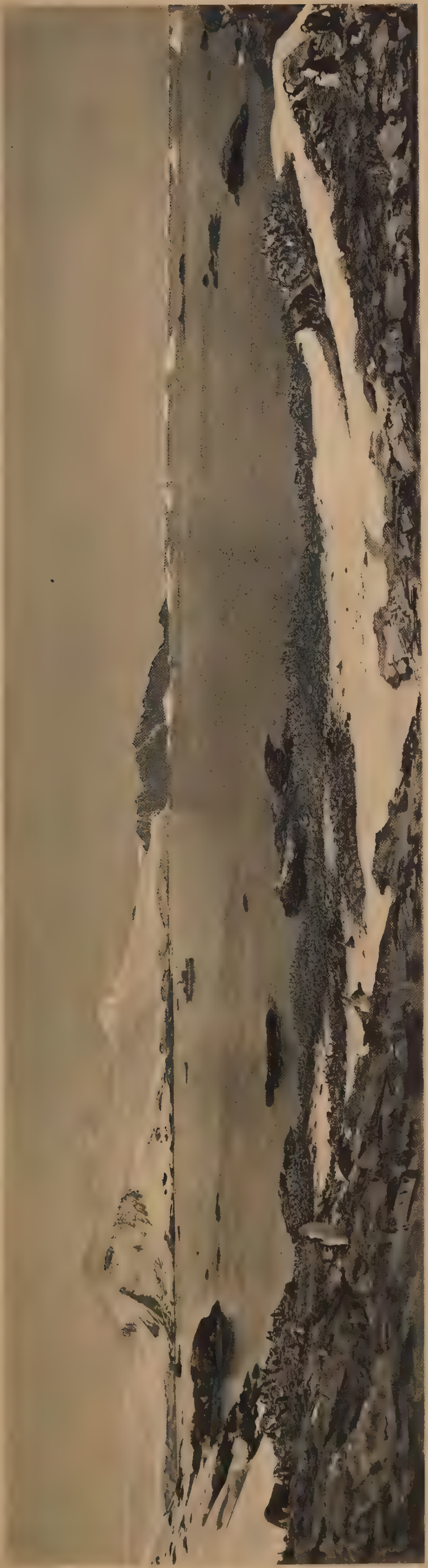
SITE OF POWELL'S LANDING, THE METEOROLOGICAL STATION,
AND WRECK OF THE "TIOGA."

PLATE XIII

Sandefjord Bay and Washington Strait

Fig. 1. Panorama of Sandefjord Bay, Coronation Island, showing the great concourse of bergs to the southward. In the centre background is Return Point.

Fig. 2. Panoramic view from 1223 feet on John Peaks showing the great fleet of bergs that was gathered about the southern approach to Washington Strait. Note how the smaller bergs are inshore, the larger out to sea. In the foreground the highland ice over the southern end of Powell Island, in the background Fredriksen Island with Washington Strait and Laurie Island beyond.



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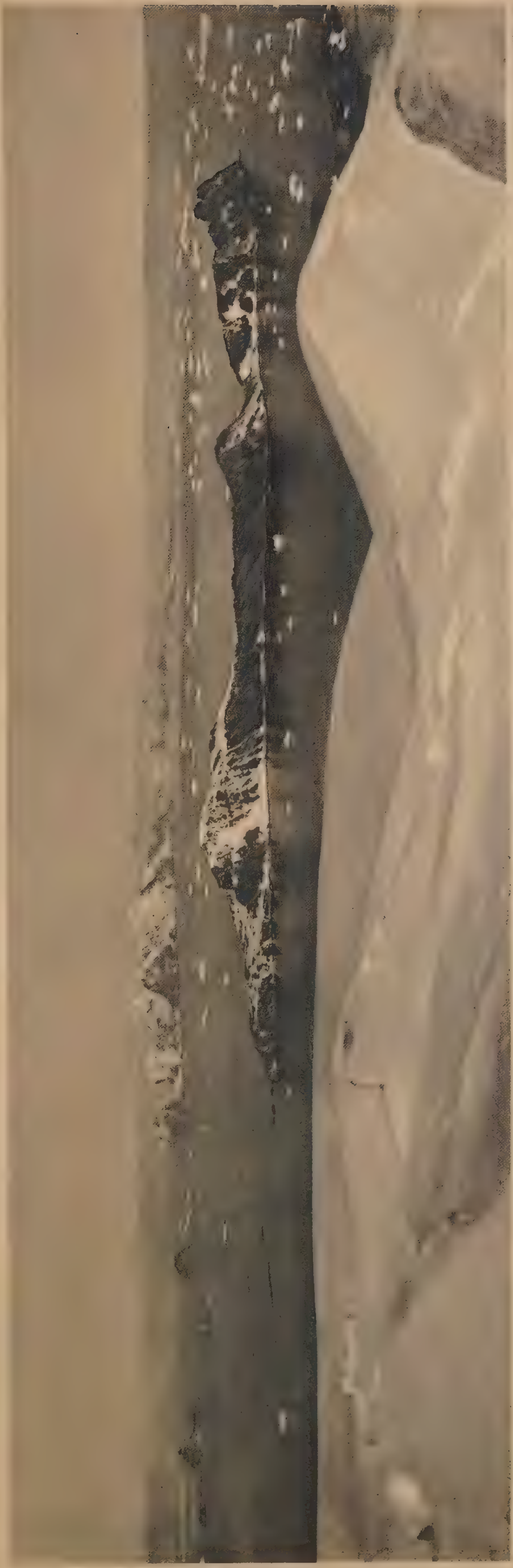

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SANDEFJORD BAY AND WASHINGTON STRAIT

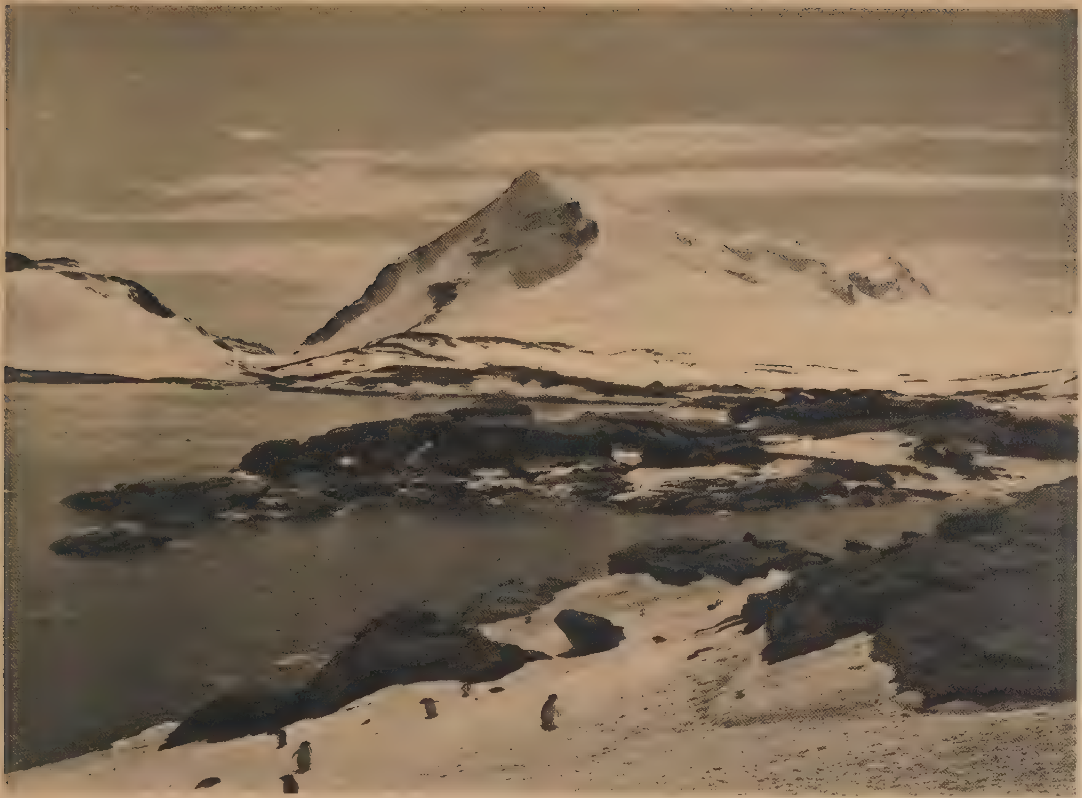
PLATE XIV

Ellefsen Harbour and Icebergs

Fig. 1. Ellefsen Harbour from the south. In the foreground the low conglomerate rocks of Michelsen Island; in the background the John Peaks (1361 feet) at the southern end of Powell Island. On the left part of Christoffersen Island. Note the light mantle of highland ice over the high land.

Fig. 2. Another view of the bergs to the southward from the summit of John Peaks. In the centre of the picture, half-hidden by the knee of the figure in the foreground, is the shallow Falkland Harbour, with Ellefsen Harbour and the low-lying Michelsen Island immediately beyond. The 'Discovery II', at anchor in Ellefsen Harbour, appears over the right shoulder of the near figure.

Fig. 3. Heavy concentration of bergs, largely water-worn, on the southern side of Coronation Island.



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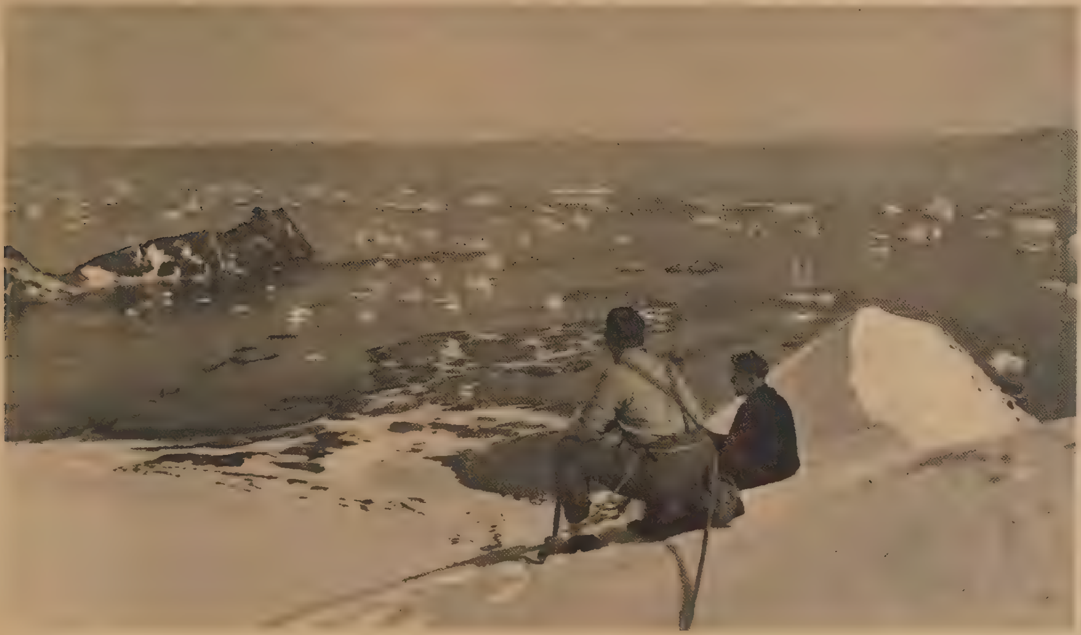

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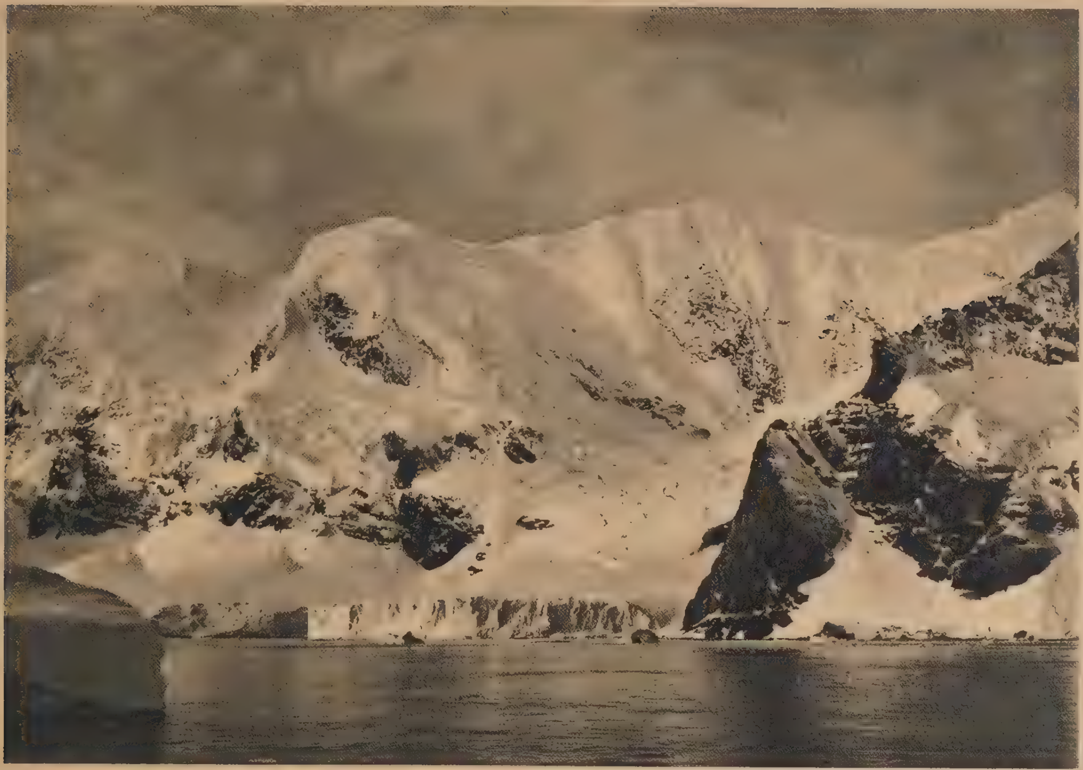
ELLEFSEN HARBOUR AND ICEBERGS

PLATE XV

Coronation Island: South Coast

Fig. 1. Looking north towards the steep southern coast of the high eastern half of the island at a point a little to the east of Signy Island. Note the conspicuous crust of highland ice along the crest of the central ridge, the confused ice-falls, and the short shelf-like ice-foot glacier below. On the right a small cliff glacier is seen clinging somewhat insecurely high up on the rock face.

Fig. 2. Looking north-east towards another part of the south coast near that shown in Fig. 1. Note the hanging glacier high up below the crest and the well-developed ice platform below.



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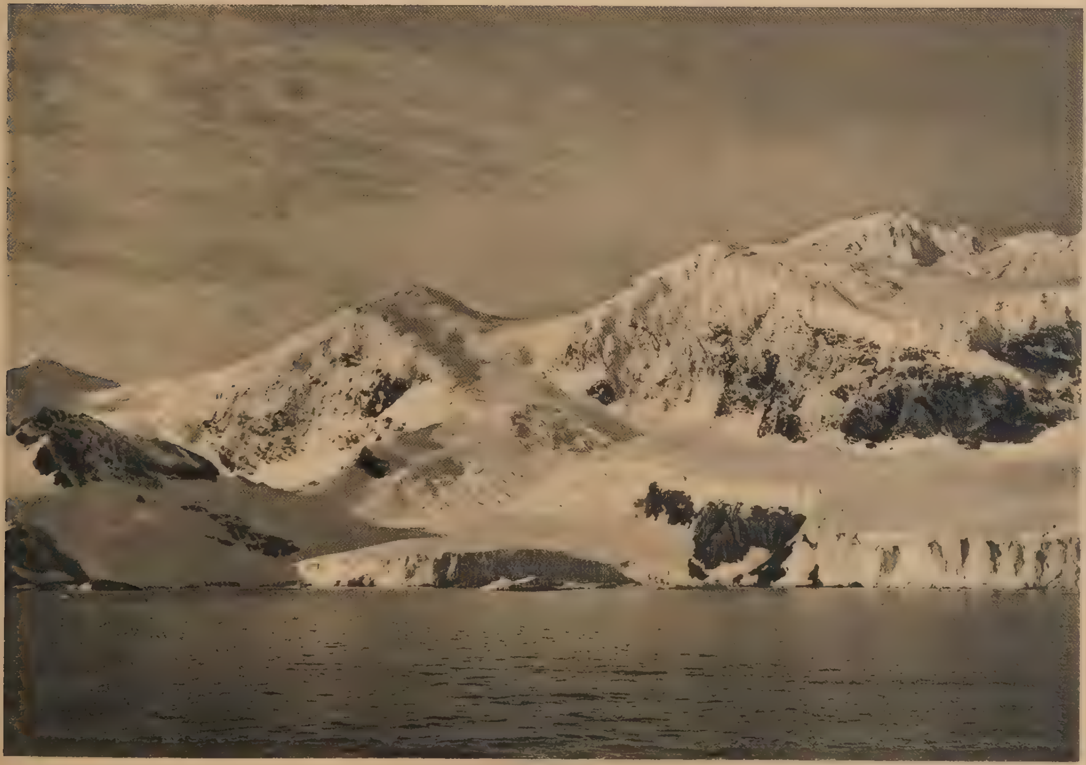

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CORONATION ISLAND: SOUTH COAST

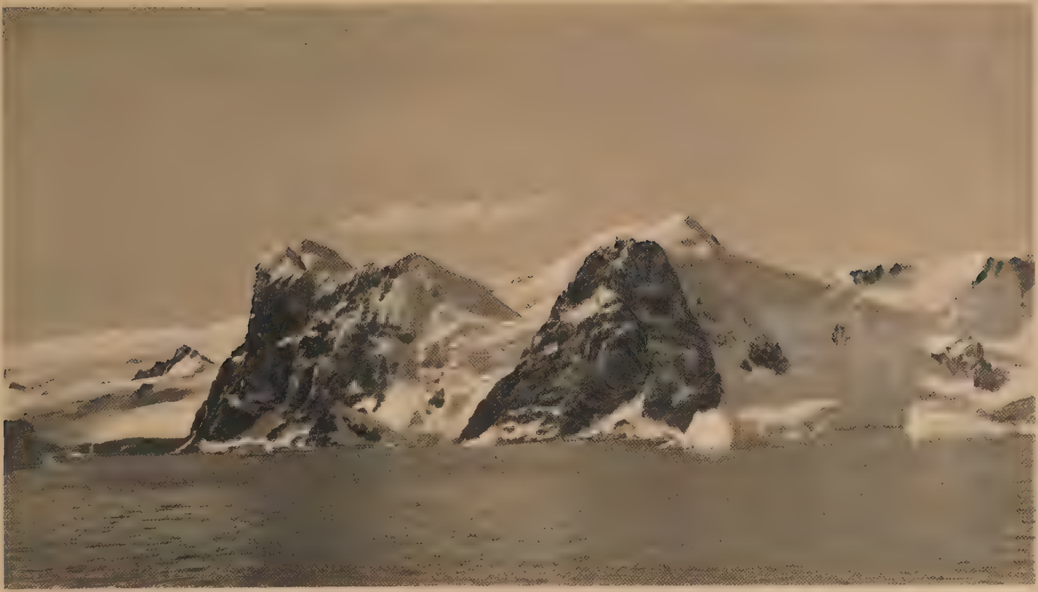
PLATE XVI

Coronation Island: South Coast

Fig. 1. Whale Bay. Two conspicuous bluffs with an ice-fall between. Left bluff bearing 330°, distant 1·8 miles.

Fig. 2. The lower western part of the island showing the marked development of highland ice. On the extreme right is the left bluff illustrated above, bearing 340°, distant 0·6 mile.

Fig. 3. Another and closer view of the above.



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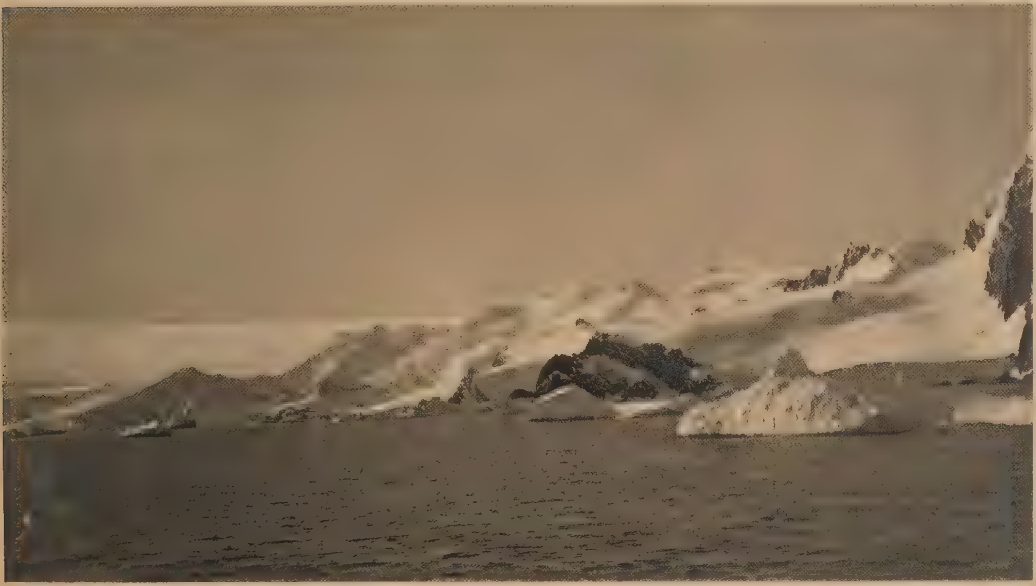

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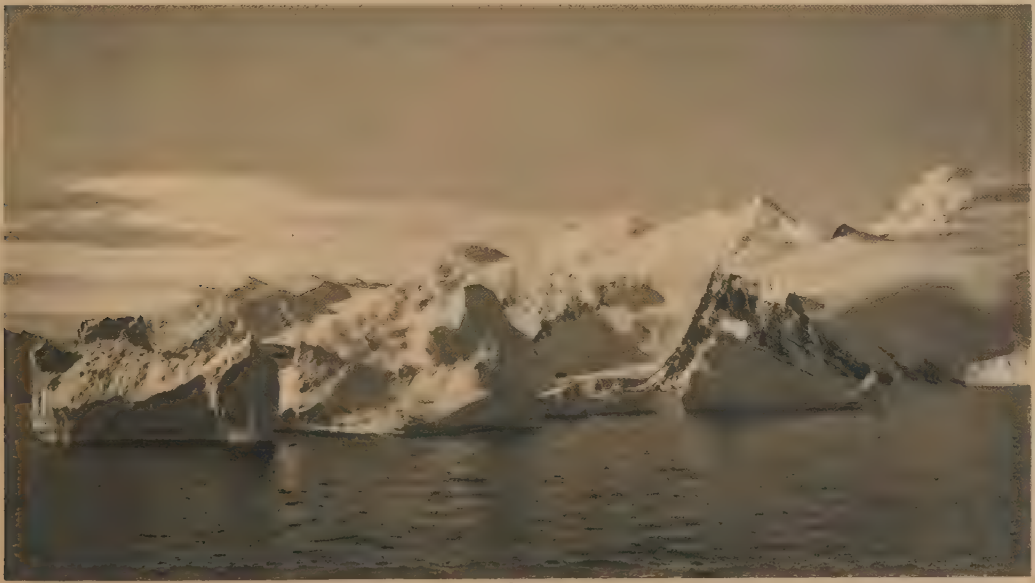

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CORONATION ISLAND: SOUTH COAST

PLATE XVII

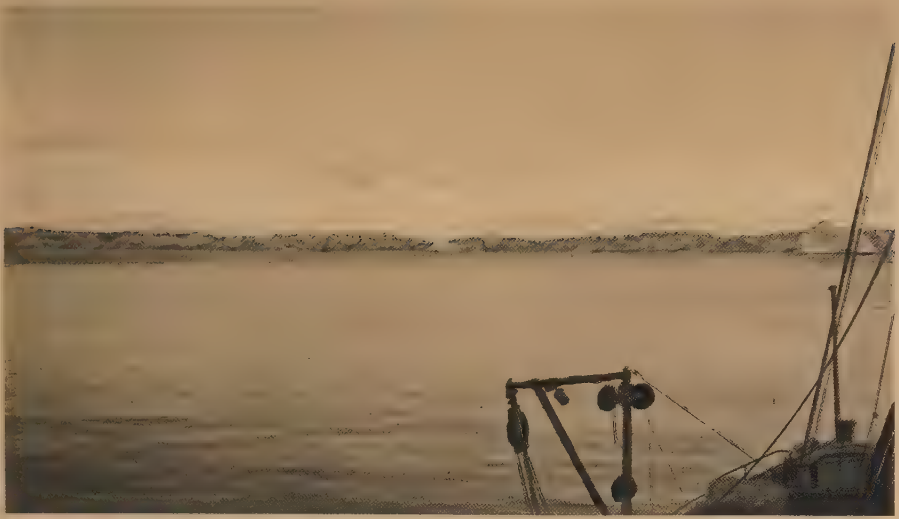
Coronation Island: Western End

Fig. 1. Looking across the narrow neck occupied by Deacon Hill. The south coast at the head of Norway Bight, showing the unbroken highland glaciation. Deacon Hill bearing 342°, distant 2·9 miles.

Fig. 2. The southern end of the west coast, or south-western corner, showing Sandefjord Peak and an ice-foot glacier continuous with the highland ice above.

Fig. 3. The middle part of the west coast bearing 090°, distant 0·8 mile. Note how the highland ice spills over in ice-falls and hanging glaciers.

Fig. 4. The southern part of the west coast. On the right Sandefjord Peak bearing 170°, distant 3·3 miles; on the extreme right the Narrows bearing 180°, distant 2·4 miles.



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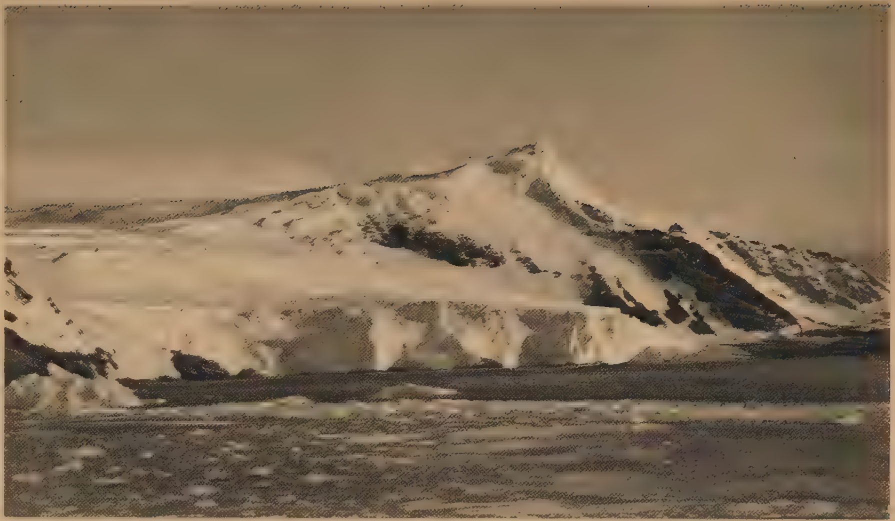

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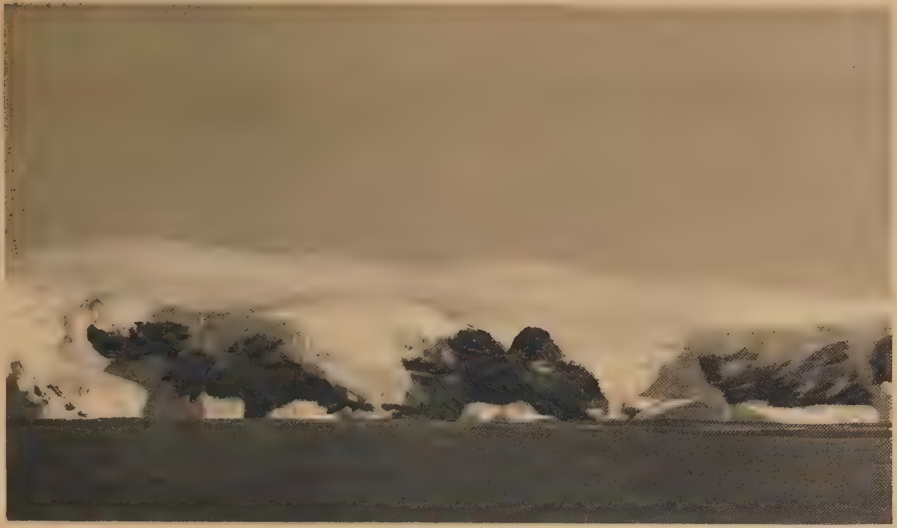

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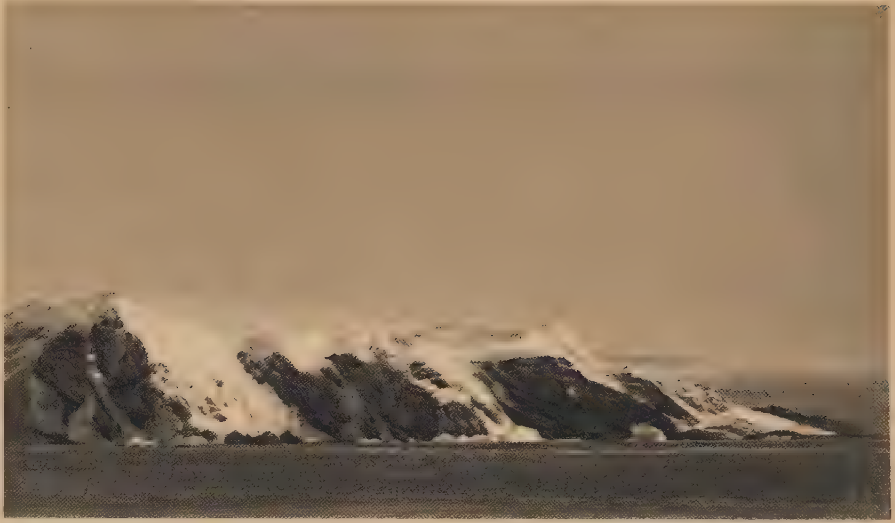

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CORONATION ISLAND: WESTERN END

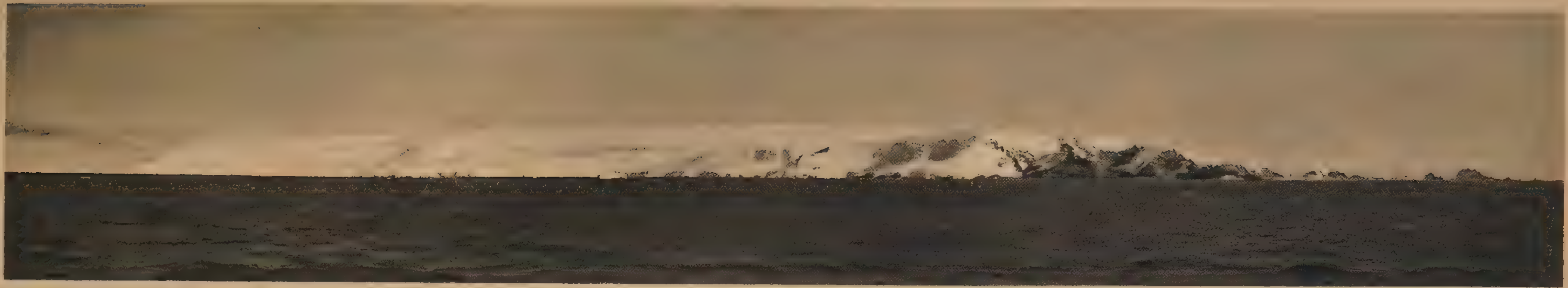
PLATE XVIII

Coronation Island: North Coast

Fig. 1. Panorama of the western half of the north coast showing the relatively low-lying land and extensive highland glaciation. In the centre of the picture appears the low, but conspicuous, Deacon Hill, a landmark visible both from the north and south.

Fig. 2. The eastern end of the north coast. On the extreme left East Cape bearing 142°, distant 1·3 miles; in the centre Cape Bennett bearing 180°, distant 0·8 mile.

Fig. 3. The north coast a little to the west of Cape Bennett showing the highland glaciation, and on the left, partly hidden by a low cloud, a glacier that is apparently of the valley type.



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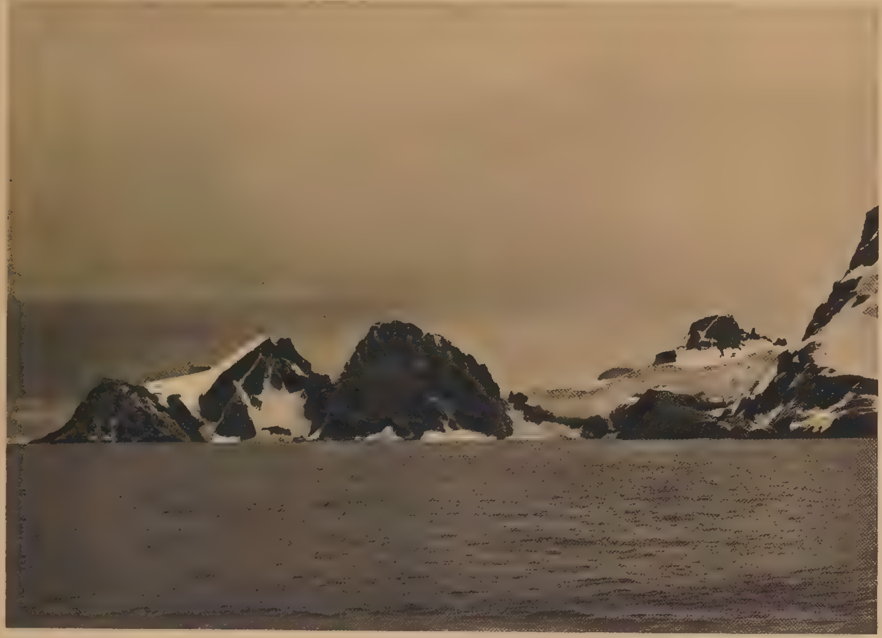

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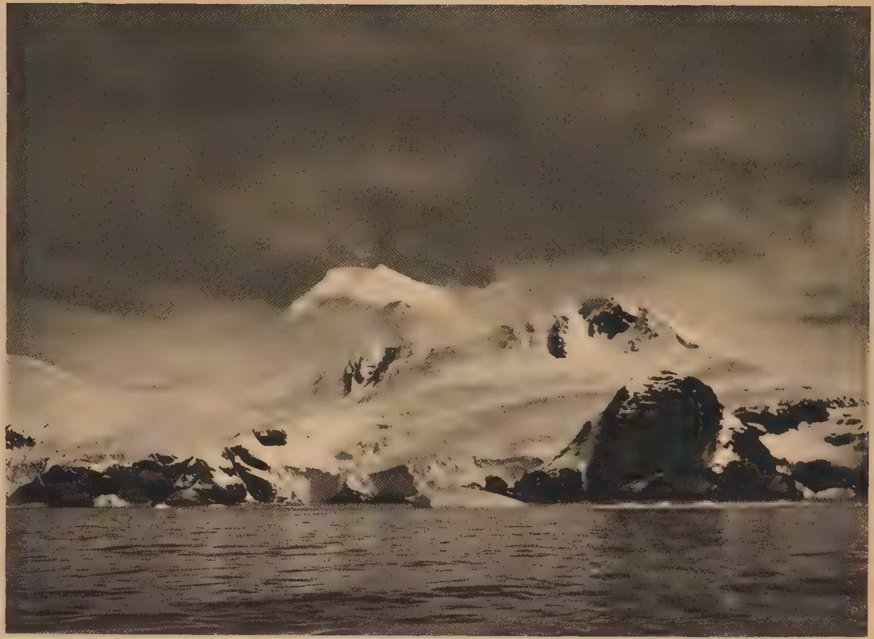

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CORONATION ISLAND: NORTH COAST

PLATE XIX

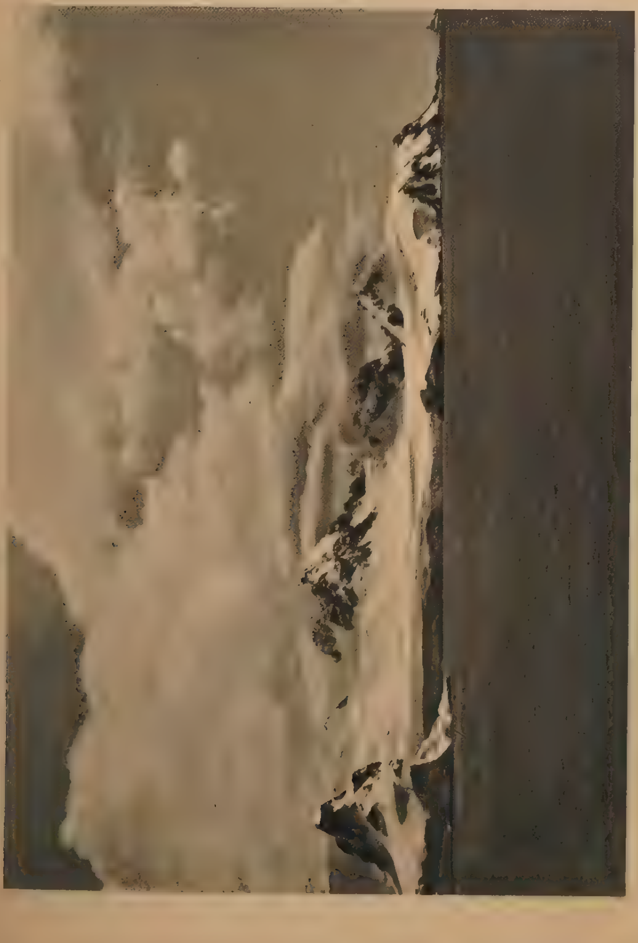
Coronation Island: East Coast

Fig. 1. The northern part of the east coast. On the right East Cape bearing 323°, distant 3·1 miles; on the left Rayner Point bearing 308°, distant 2·0 miles.

Fig. 2. A closer view of the same part of the coast looking west-north-west. On the left of the centre, partially hidden by a low berg, is Gibbon Bay. Note in Figs. 1 and 2 the marked development of ice-foot glaciation.

Fig. 3. Ice-cliff 190 feet high at the head of Gibbon Bay, distant 0·2 mile.

Fig. 4. Looking due west into Petters Bay, distant 0·2 mile. Note in the foreground the fringing ice-foot glacier, and the narrow ice tongue behind resembling a valley glacier.



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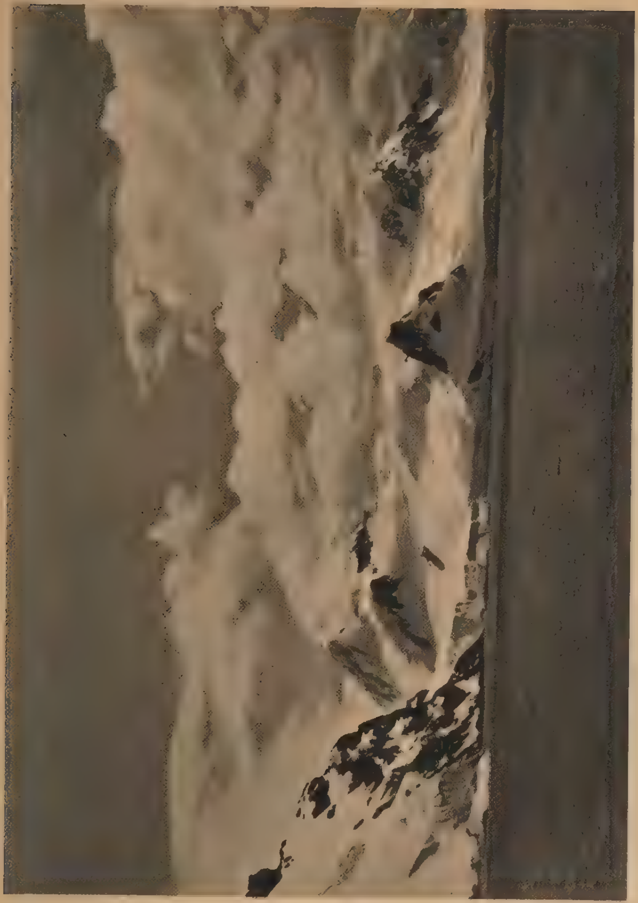

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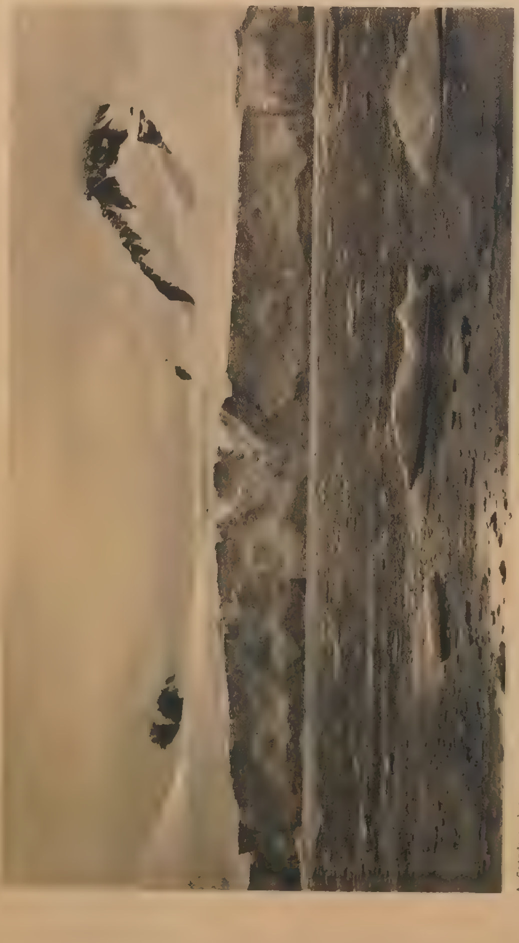

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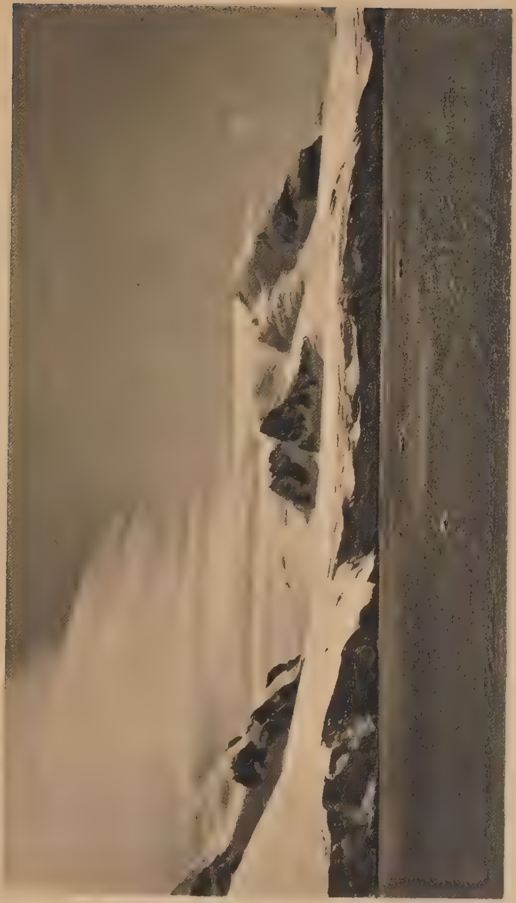

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CORONATION ISLAND: EAST COAST

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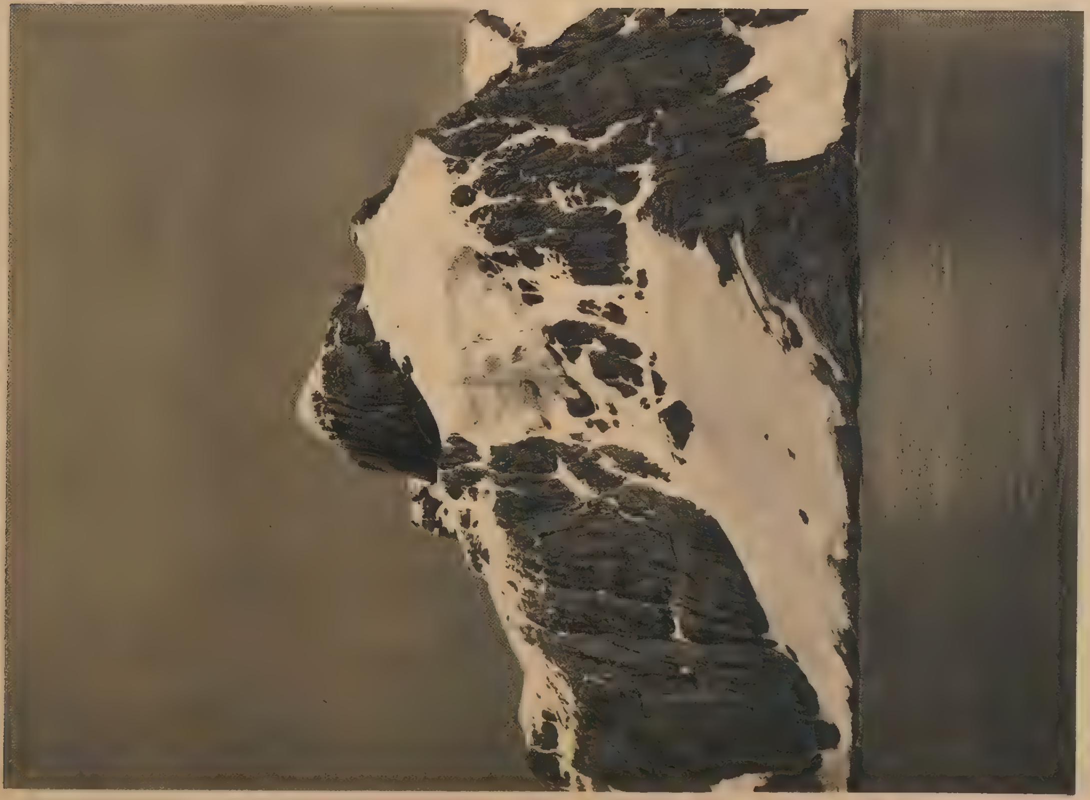
PLATE XX

Coronation Island: East Coast

Fig. 1. The Turret, an imposing rock buttress on the eastern coast near Gibbon Bay. Seen from the north-east, distant 0·5 mile. Note the small cliff glacier suspended high up on the rock face.

Fig. 2. Another view of the Turret from the east, distant 0·2 mile. Note the steep cliff glacier reaching the sea.



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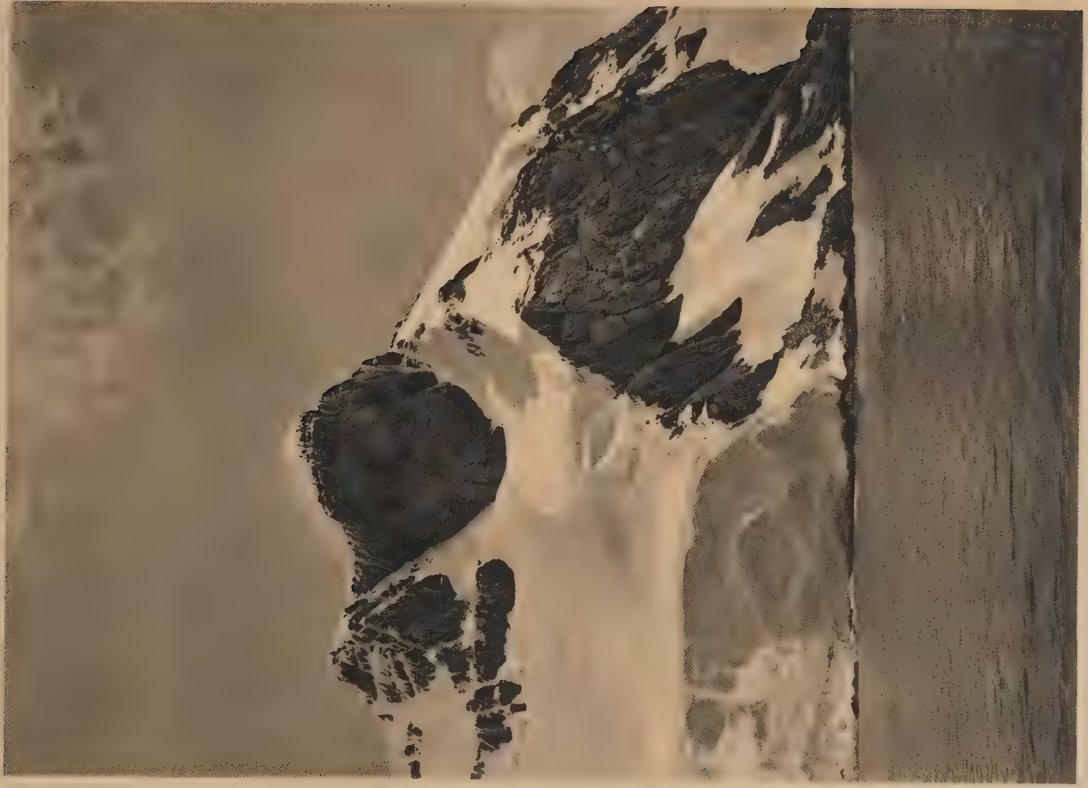

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CORONATION ISLAND: EAST COAST

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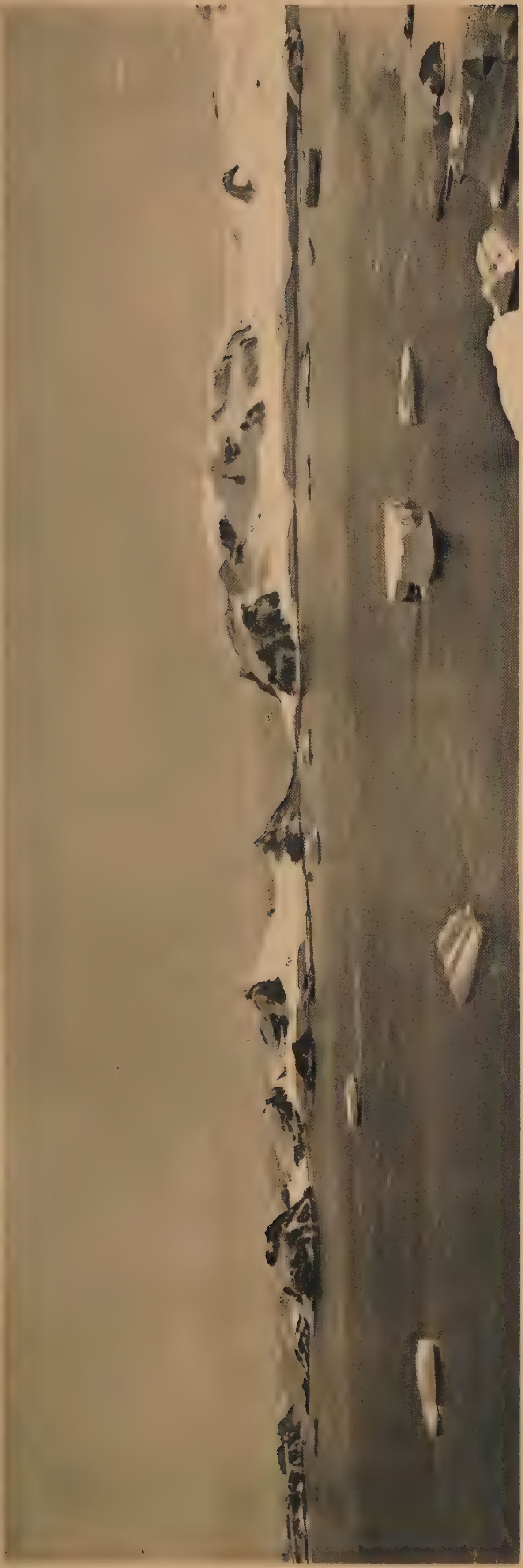
PLATE XXI

Coronation Island: East Coast

Fig. 1. Looking across Lewthwaite Strait at the southern part of the east coast: panoramic view from a height of 1223 feet on John Peaks. On the extreme left South Cape with the Robertson Islands beyond; in the centre the low Divide. Note on the right the broad ice-foot glacier, and projecting through the ice, the isolated rock pinnacle that perhaps represents all that is left of a former dividing ridge.

Fig. 2. The Divide bearing 058°, distant 1·0 mile.

Fig. 3. A closer view of the Divide bearing 250°, distant 0·5 mile.



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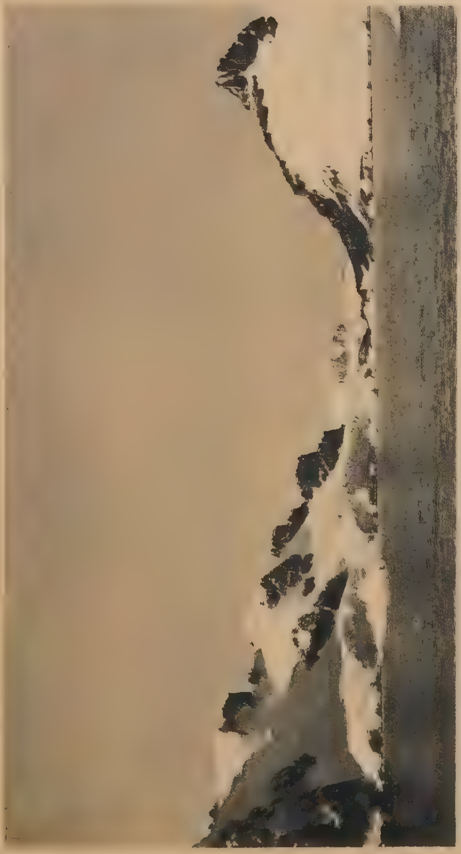

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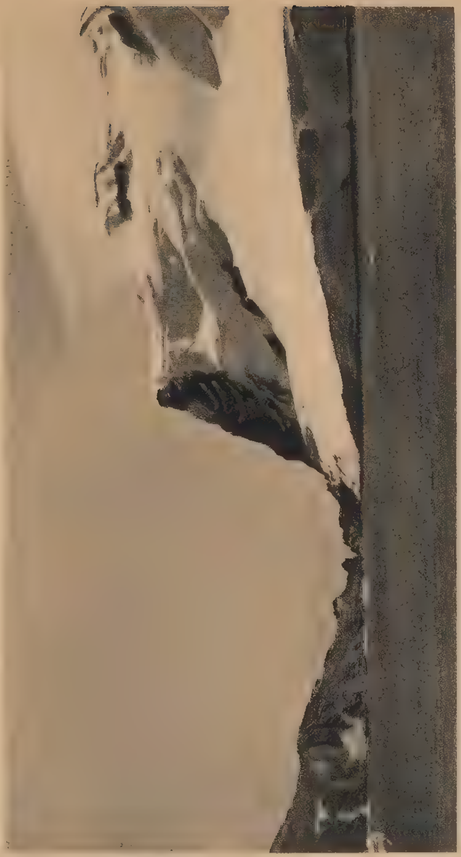

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CORONATION ISLAND: EAST COAST

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PLATE XXII

Signy and Powell Islands

Fig. 1. Panorama of the east coast of Signy Island. Note the light snow and ice field and the relatively ice-free coast.

Fig. 2. The southern end of Powell Island, with John Peaks, from the south, distant 2·0 miles. Note the light highland glaciation.

Fig. 3. The northern part of the west coast of Powell Island from Lewthwaite Strait, showing a suspended cliff glacier and a somewhat heavier highland glaciation. The point on the left bears 018°, distant 2·4 miles.

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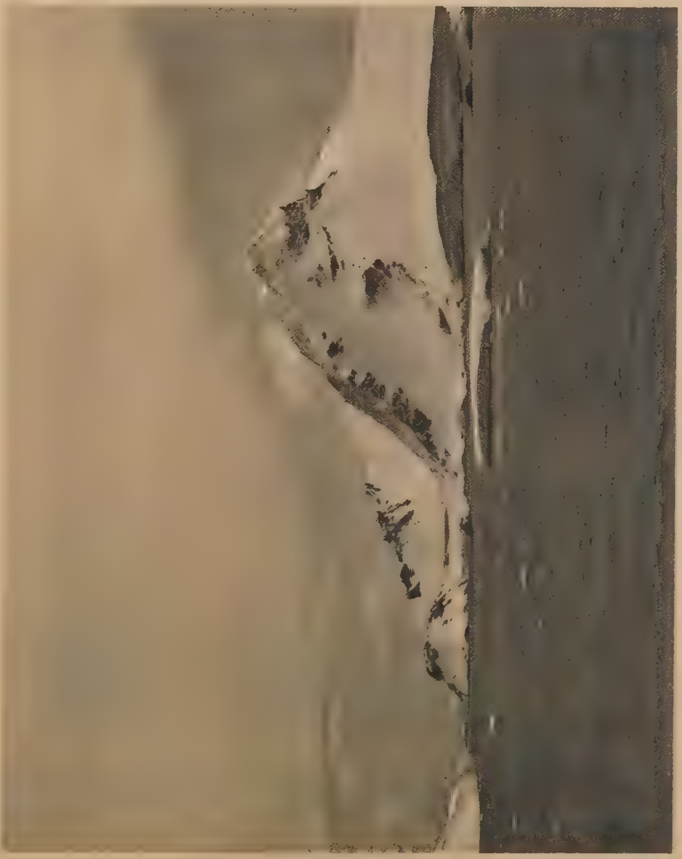

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SIGNY AND POWELL ISLANDS

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PLATE XXIII

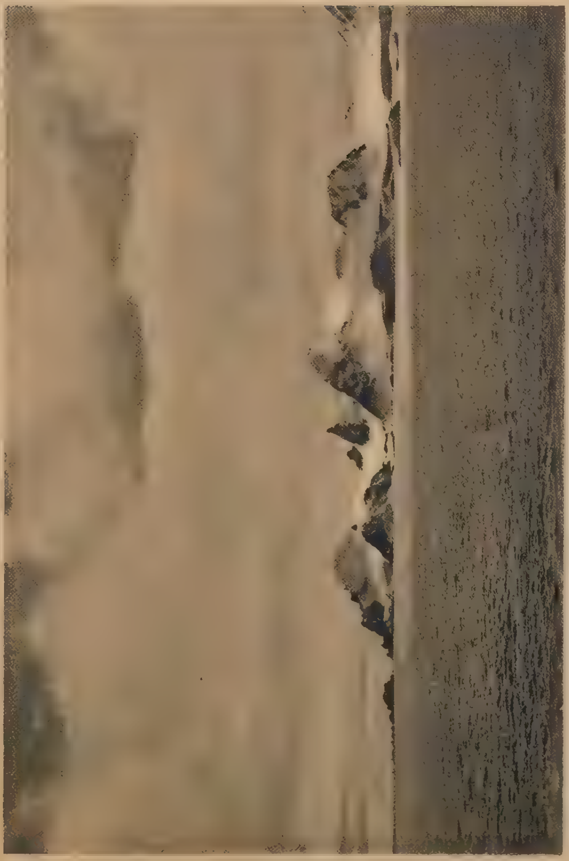
Fredriksen and Laurie Islands

Fig. 1. Panorama of the west coast of Fredriksen Island.

Fig. 2. Laurie Island: the west coast of Pirie Peninsula showing ice-foot glaciers. On the left Cape Mabel bearing 044°, distant 2·2 miles.

Fig. 3. Laurie Island: the southern tip of Mossman Peninsula showing the remarkable rock formation at Cape Hartree. The point of the cape bears 121°, distant 2·2 miles.

FREDRIKSEN AND LAURIE ISLANDS



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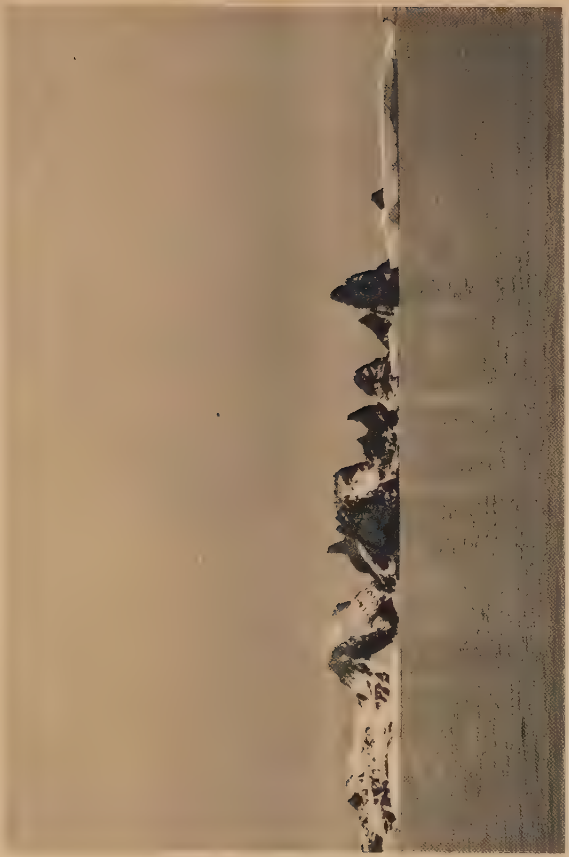

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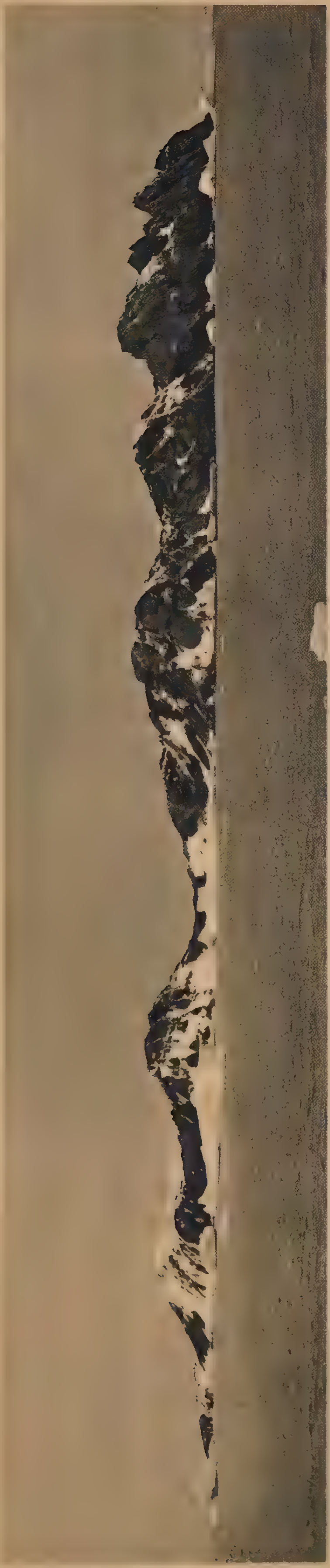

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PLATE XXIV

The Inaccessible Islands

Fig. 1. "Three spiral rocks quite inaccessible", the first landfall to be made at the South Orkneys. The Inaccessible Islands seen from the east, distant about 5 miles. Note the light snow-cap on the highest and southernmost islet.

Fig. 2. High Island bearing 154°, distant 0·3 mile.

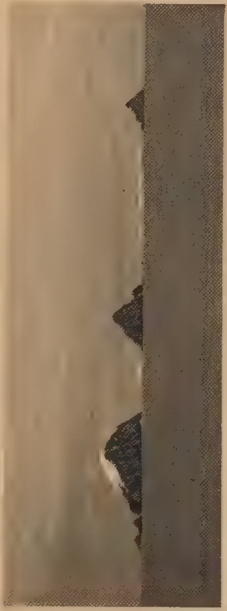
Fig. 3. High Island bearing 090°, distant 0·3 mile.

Fig. 4. Middle Island bearing 100°, distant 0·2 mile.

Fig. 5. Middle Island bearing 300°, distant 0·2 mile.

Fig. 6. Small Island bearing 270°, distant 0·3 mile.

Fig. 7. Small Island bearing 352°, distant 0·8 mile.



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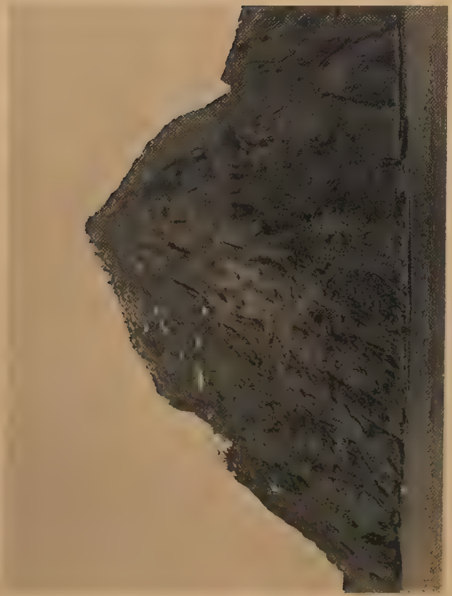

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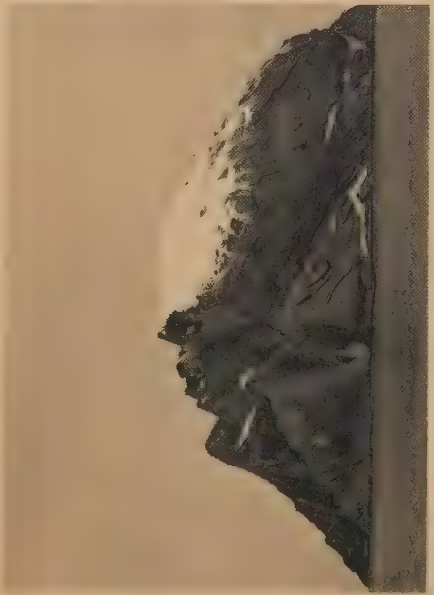

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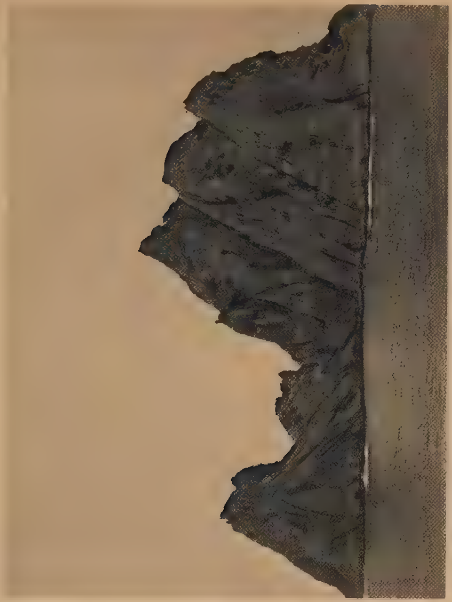

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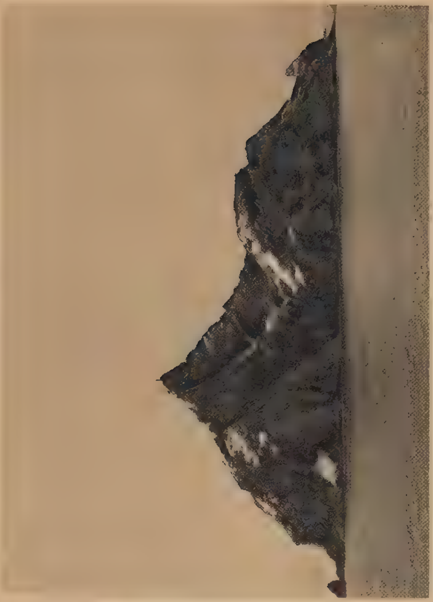

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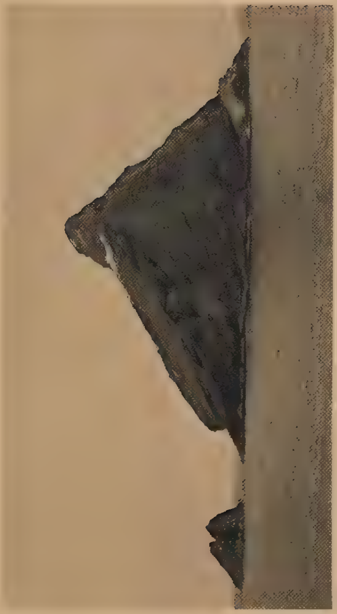

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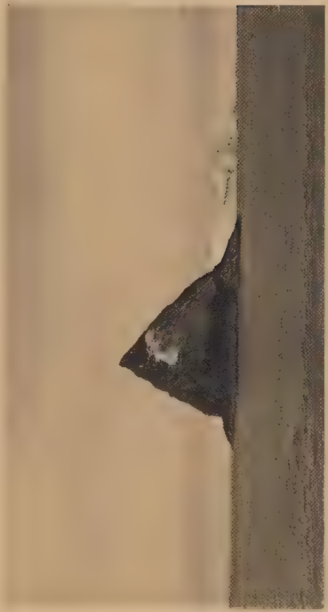

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THE INACCESSIBLE ISLANDS

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PLATE XXV

Smaller islands, islets and rocks

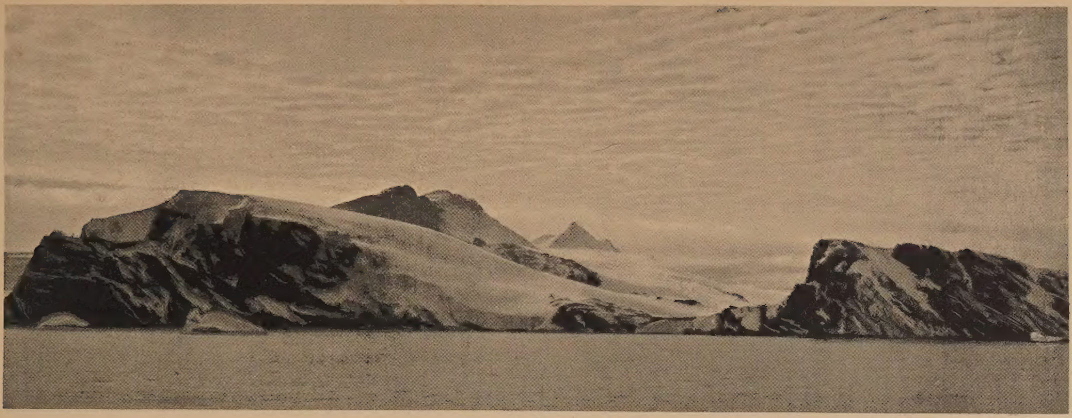
Fig. 1. The largest of the Larsen Islands at the south-west corner of Coronation Island. Sandefjord Peak in the near background.

Fig. 2. Isolated rocks off the west coast of Coronation Island. In the foreground Despair Rocks bearing 059°, distant 1·0 mile; in the distance Melsom Island bearing 027°, distant 3·1 miles.

Fig. 3. The twin peaks of Saddle Island bearing 330°, distant 2·6 miles. The summit of the near peak is hidden in cloud. The dark island on the left is Weddell Island bearing 311°, distant 1·9 miles.

Fig. 4. Weddell Island bearing 255°, distant 0·5 mile.

PLATE XXV



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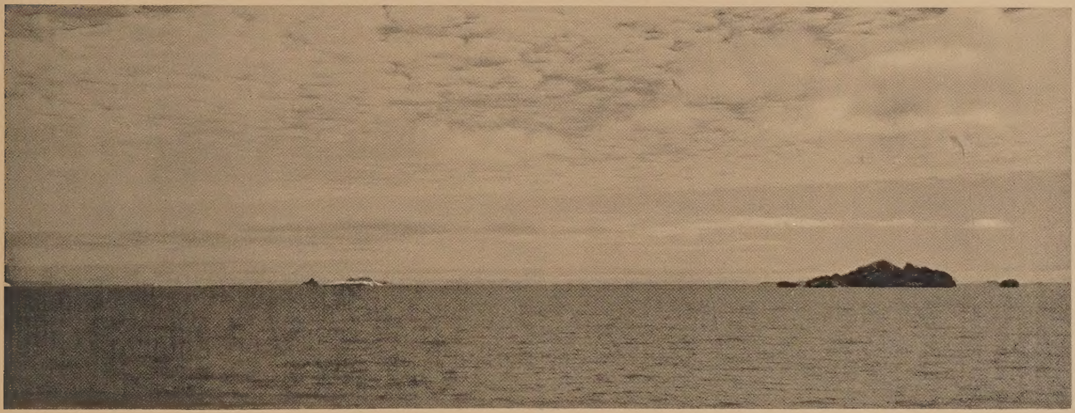

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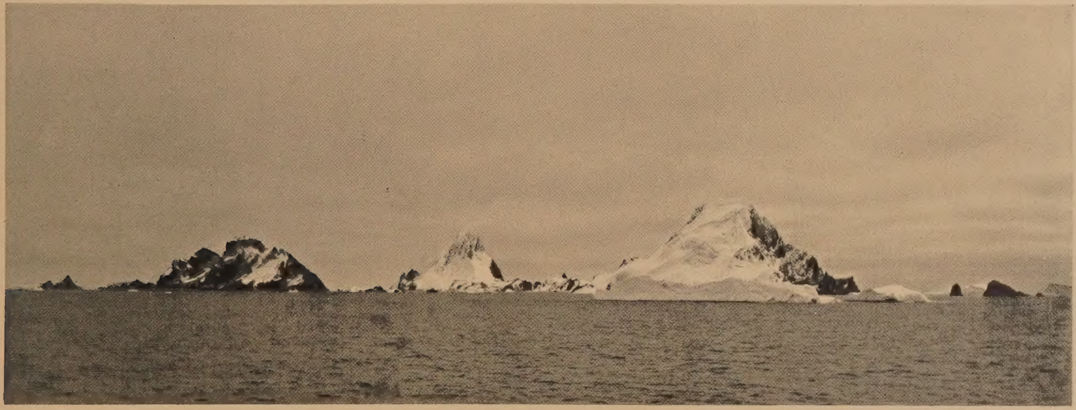

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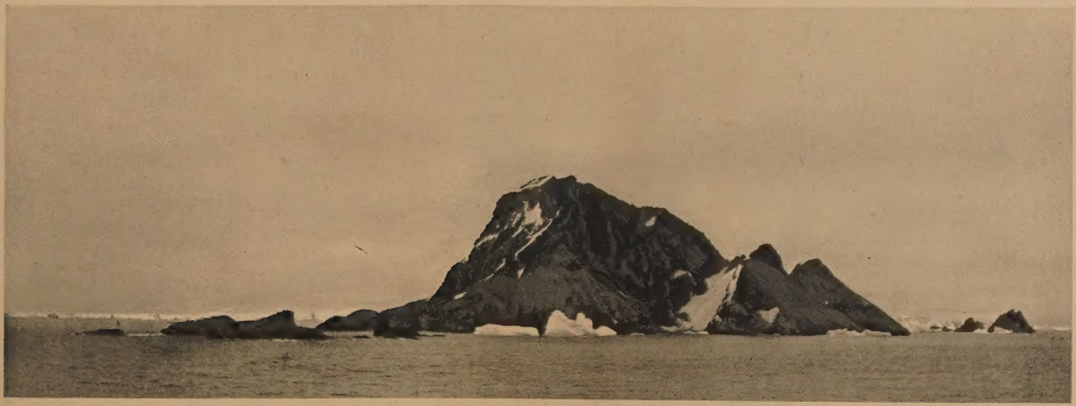

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SMALLER ISLANDS, ISLETS AND ROCKS